# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

JANUARY 1913.

## GENERAL PHYSICS.

1. *Sensitive Manometer.* **A. Piccard.** (Archives des Sciences, 34. pp. 258–260, Sept., 1912. Paper read before the Soc. Suisse de Physique, Altdorf, Sept., 1912.)—The apparatus is based on the principle of a U-tube containing at the middle a column of water. One end of the tube is bent downwards to dip into a vessel of water of large surface area, which can be moved in a vertical direction by means of a micrometer screw. The other end passes into a wider tube which has two outlet tubes, each provided with a tap; one of these outlets is at the top A of the wider tube, the other at the bottom B. The water meniscus in the narrow tube is observed with a microscope provided with a horizontal cross-wire. To ensure cleanliness of the tube walls, tap A is closed and a stream of hot sulphuric acid with potassium dichromate is passed in at B and right through the tube. Water, specially pure, is then gradually substituted for the cleaning mixture, until finally the apparatus is filled with pure water. Tap B is then closed, and A opened to the pressure to be measured, and the micrometer screw is turned until the meniscus is again in its original position. The difference of the micrometer readings then gives the required pressure. To keep the meniscus in excellent condition it is necessary only to allow air which has been filtered and saturated with moisture to enter the apparatus at A.

A. W.

2. *An Electric Micrometer.* **B. Thieme.** (Zeitschr. Instrumentenk. 32. pp. 322–325, Oct., 1912.)—A fine micrometer screw is mounted on a rigid frame, and by gearing can be rotated by small angles, and readings of 1/10000 mm. obtained. Electrical, not mechanical, touch is employed, a galvanoscope being used as indicator. The error claimed for this arrangement in the measurement of a slab of nearly an inch is ± 0·00010 mm.

P. E. S.

3. *International Time Conference.* **J. Reyval.** (Lumière Électr. 20. pp. 177–180, Nov. 9, 1912.)—On the initiative of the Bureau des Longitudes

a meeting was held at Paris on Oct. 15, 1912. A definite programme was agreed upon. Resolutions were passed arranging for each of a series of stations round the earth to receive time signals both by day and night, the number in general not to exceed four every 24 hours. From the 1st of Jan., 1913, the following stations will co-operate in issuing wireless time signals at the hours stated :—

| Station. | Greenwich Mean Time. | Station. | Greenwich Mean Time. |
|---|---|---|---|
| Paris | 0 h. midnight | Norddeich | 12 h. midday |
| Brazil (San Fernando) | 2 a.m. | Brazil (San Fernando) | 16 p.m. |
| United States (Arlington) | 3 | United States (Arlington) | 17 |
| Mogadisco (Somaliland) | 4 | Massowah (Erythraea) | 18 |
| Manila | 4 | San Francisco | 20 |
| Timbuctoo | 6 | Norddeich | 22 |
| Paris | 10 | | |

These hourly signals will be sent out with a uniform wave-length of 2500 m. The executive is to be an International Time Bureau, localised at Paris, and the various stations co-operating in the unification. It is hoped that all ships will be equipped with the necessary receiving apparatus, so that they may be able to correct their chronometers at any part of a voyage. Ice warnings are also to be distributed systematically. Certain groups of signals giving summaries of meteorological data are now being sent out regularly from the Eiffel Tower at Paris, and it is hoped to augment this service. A special committee was constituted to examine into the study of Hertzian-wave transmission and reception ; experiments are to be made at the high-power station at Brussels. C. P. B.

4. *Motion of a Disc on a Rough Plane.* **P. Field.** (Phys. Rev. 35. pp. 177–184, Sept., 1912.)—A mathematical treatment of the motion on a rough plane of a disc with three supports. The motion is studied (*a*) when the disc, with three short legs, is initially given a large angular velocity about an axis perpendicular to its plane and passing through its centroid ; (*b*) when the disc is initially given a velocity of translation only. The equations of motions are stated, and approximate solutions given. A. W.

5. *Elastic Properties of Bismuth Wires.* **J. E. Harris.** (Phys. Rev. 35. pp. 95–119, Aug., 1912.)—On investigating the elastic properties of bismuth wires, it was found that they exhibit some of the peculiar properties possessed by the Pt-Ir wires examined by Guthe and Sieg [see Abstract No. 872 (1910)]. When the wires were vibrated torsionally a great decrease in the period of vibration and the logarithmic decrement was observed when the amplitude decreased. The curves for the Bi wires representing the relations between (*a*) the period and amplitude, (*b*) the logarithmic decrement and amplitude, and (*c*) the period and vibration number, were found to differ in some respects from those of the Pt-Ir wires, but the amplitudes in the case of the latter were greater in some cases than could be reached by Bi wires, because of the low elastic limit of Bi. It was found that in two experiments in which the mass of the vibrating system was kept constant but the moment of inertia varied, the period-amplitude curves in the two cases could be made to coincide by applying a reduction factor to the periods in one set of observations. This reduction factor was found to be equal to the ratio of the

square roots of the moments of inertia used in the two experiments. This indicates that the mathematical relation between the period and amplitude does not depend upon the rapidity of motion of the vibrating system. The log. decrement-amplitude curves in the two cases were found to coincide. When the load as well as the moment of inertia was varied, on applying the proper reduction factor to the periods the two curves did not coincide, the curve corresponding to the vibrating system having the smaller mass being flatter than the other. The greater values of the log. decrement were found in the case in which the suspended mass was greatest. On varying the length of the wire the results indicated that the period is the same general function of the amplitude in all cases. This also indicates that the wire is uniform throughout its length, and that its peculiar behaviour is not due to any particular section of the wire. Two wires of different diam. were arranged with suspended masses such that the stresses to which the wires were subjected were the same in each case. By applying the proper factors to the amplitudes and periods the curves could be made to coincide. The log. decrement curve for the smaller wire was found to lie above that for the wire of larger diam., indicating a greater damping effect in the former.

J. J. S.

6. *Experiments on the Strength and Fatigue Properties of Welded Joints in Iron and Steel.* **T. E. Stanton** and **J. R. Pannell.** (Inst. Civ. Engin., Proc. 188. pp. 1–31; Discussion and Correspondence, pp. 32–77, 1911–1912.)—The tests were partly suggested and guided by the Charing Cross roof failure of 1906, and aimed at getting an estimate of the value of welds by various makers and processes, relative to the unwelded materials. Tensile tests by Böhme, in Berlin, gave low efficiencies and small elongation and contraction of area for ingot irons, whereas tests by Huysfeld at Prevali showed efficiencies of 99 per cent., which are attributed by the authors to the elaborate mechanical treatment undergone after welding. Bauschinger in 1885 found lower efficiencies, but concluded that good mild-steel welds may be made with proper care in heating. The present specimens were submitted to complete static loading tests, the total elongation, $e$, being given by $a + bl$, where $l =$ length, $a$ and $b$ constants. The first term is the local, and the second the general extension. The specimens were mapped in 1-in. gauge lengths, and the results give curves of extensions consisting of two parallel straight lines connected by an S-curve, the vertical intercept between these lines being the local extension. For alternating tests the Wöhler cantilever method was employed. As a result of preliminary tests it was concluded that Reynolds and Smith's speed effect on endurance does not apply to the apparatus now used, so the tests were run at 2000 alternations per min. To ensure that the max. stress should occur at the centre of the weld the specimens were turned with a shoulder at that position, the wider part being held in the chuck, whilst they were made hollow to some distance beyond the weld to reduce the time occupied in the tests. It was sometimes necessary to predict the limiting range from a test in which fracture occurred after a moderate number of reversals of a material of which only one specimen was available. In such cases a standard endurance curve was obtained for a material of very similar properties, and it was assumed that the limiting range of the single specimen had the same ratio to the standard limit as did the range at the given number of reversals to that of the standard. The authors conclude that the local elongation is the best criterion of efficiency. The most important result is that although the welds

are locally brittle, as Bauschinger found, and give a small local contraction, that is not fatal to resistance to alternating stresses, a definite failure having in all cases been traced to a place in the joint where actual welding has not taken place. If 70 per cent. static strength be taken as the lowest limit of a good weld, the results show bad welds as follows :—5 in 21 hand-welded steel, 2 in 24 hand-welded iron, 1 in 8 electric-welded steel, 0 in 7 electric-welded iron. Acetylene-welded joints are uniformly worse than any others. The electric method gives the most uniform results. The slight inferiority of electric- compared with hand-welds to resist fatigue may be due to the particular practice of the maker and not to the general process. As a broad conclusion the subjection of each weld in a structure to a proof-load is suggested. In the *discussion*, **Stanton** mentioned further tests showing no advantage from annealing. Further, 1⅜-in. bars welded and then forged down to ¾-in. gave results comparable with the Prevali figures, showing that mechanical working helps to obtain a perfect weld. **E. Matheson** pointed out the suitability of electric welding for the hardware and small trades handling many duplicates where the cost of special jaws and accessories is distributed. The dangers of sulphur in a coke fire limited the use of steel for ordinary welding ; it was not found in crane-chains or draw-bars. Metal for welding must be puddled and not originate in a cast ingot. **C. E. Strohmeyer** objected to the recommendation of a proof-load without so treating the test specimen : they might thereby be seriously injured. Welds should not be used in structural ties. He suggested placing the shank of the test-piece entirely outside the weld and distributing the stress uniformly over the latter by turning it taper. He suggested the formula $S = F + C^4\surd(10^6/R)$, where $S$ = stress, $F$ = fatigue limit, $R$ = revolutions, and criticised the use of the standard curve. **W. White** would avoid welds in tension members if possible, and would use a proof-load. He had observed "rotting" of metal around welds. **W. G. Kirkaldy** described his own tests. He agreed with Böhme that ingot iron should not be welded. The Prevali tests were of little value as the mechanical working was ordinarily impracticable. Many bad welds were caused by making the "scarf" concave so as to make a neat joint externally but hollow inside. The boring-out of the test specimens might have removed this faulty part, giving too favourable results. The spreading of initial unsoundness was more to be feared than damage from heat-treatment. **R. Appleyard** described the welding of iron and steel sheathing-wire for submarine cables. The presence of impurities made hand-welding impracticable ; electric welding gave a perfect joint, but there was always a weakness due to molecular changes in the material. He suggested the recording of the rate of loading in the tests to eliminate the inertia factor of the testing machine. **P. B. Brown** mentioned that aluminium is fatal to hand-welding. **C. H. Wingfield** criticised the taking of equal tensile and compressive stresses in the fatigue tests. He suggested that, for welds as for other materials, the safe range decreases, as the upper limit of stress is raised, according to a linear law. He suggested the location of welds in steel by a magnet deflection method, and described an arrangement of induction coils with a telephone receiver for the same purpose. **J. O. Arnold** objected to the Wöhler test as not investigating the factors of rapidity of loading and contingencies. **W. Beardmore** recommended annealing after welding to relieve the local brittleness. The steel should be heated to the refining temperature, cooled in the air to the $Ar_1$ point, and thence cooled slowly in the furnace.

E. J. S.

**7.** *The Strength of Struts.* **R. V. Southwell.** (Engineering, 94. pp. 249–250, Aug. 23, 1912.)—Practical experience shows that Euler's strut formula is sufficiently accurate if the conditions assumed hold true, namely, that the strut is initially straight; that loading is truly axial; and that the length is so great that the thrust cannot produce elastic breakdown before flexure begins. No serious error is introduced by assuming the first two, but the third condition is not justified for any but long struts. The author amends the theory to take account of elastic yield as revealed by a compressive stress-strain diagram for the material. If the material be stressed to a point beyond the elastic limit and the load is taken off, the diagram follows a line parallel to the original line of elastic strain, *i.e.*, the ratio (decrease of stress)/(decrease of strain) = E, the modulus of elasticity. But, if the load be increased, that ratio has a much smaller value, E′, given by the slope of the stress-strain curve. E′ has a value depending on the load at which instability commences. The effect of distortion is to relieve the strain on one side of the axis where the "apparent modulus" is E and to increase it on the other side, the modulus being E′. Thence, although the conservation of plane sections may be assumed, the centroid of stress no longer coincides with the centre of area. The case of a rectangular strut of breadth 2$t$ and depth $a$ is considered. The centre of stress is located by the consideration that the total action remains unchanged. The bending moment is integrated over the two parts of the section, the ordinary theory of elastic bending being used. The resulting differential equation, obtained by equating to the external bending moment, is—

$$p \,.\, y + d^2y/dx^2 \times \tfrac{2}{3}\mathrm{E}t^3[1 + \tfrac{1}{4}(1 - \mathrm{E}'/\mathrm{E})(b^2/t^2 - 8b/t - 2)] = 0 \quad \ldots(1),$$

where $y$ is the deflection of the centre of area from its initial position, $p$ is the intensity of compressive stress on the section just before collapse, $x$ the distance of the section from one end, and $b$ the eccentricity of the centre of stress. Euler's equation reads—

$$p \,.\, y + d^2y/dx^2 \times \tfrac{2}{3}\mathrm{E}t^3 = 0 \quad \ldots\ldots\ldots\ldots(2).$$

If $l$ is the length of strut, calculated from equation (2), which will just support stress $p$, and $l'$ is the length from equation (1), then $l'/l$ reduces to $2/[1 + \sqrt{(\mathrm{E}/\mathrm{E}')}]$. This simple relation holds for rectangular sections, but similar results may be deduced for other sections by making suitable approximations. Plotting E′/E against $l'/l$ for rectangular, solid round, and thin tubular sections shows that for medium lengths the form of section has no serious influence, though the small variation found confirms Lilly's experimental work. Curves are given of collapsing stress against length/radius of gyration as derived experimentally by Lilly, together with the latter's empirical Rankine-Gordon curves. Further curves show the result of using Euler's theorem and the present theory. It is seen that the last shows a much closer approximation throughout to practice than do any of the others. The new theory, moreover, demonstrates a temporary reappearance of stability in the region of the yield-point, which was clearly shown in Lilly's tests.

E. J. S.

**8.** *Stress Distribution in Drilled Tie-rods.* **E. Preuss.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1780–1783, Nov. 2, 1912.)—Designers often make the erroneous assumption that the stress-distribution on the sections of a tie containing a hole is uniform. Kirsch and Föppl have shown theoretically for an infinitely broad rod that the stress at the edge of the hole is independent of the diam., and equal to about three times the value calculated on the assumption of uniform distribution. The present tests were made on specimens all 120 mm. wide, with holes of 15, 30, 50, and 70 mm. diam. An axial tensile load was applied by means of bolts passing through the specimen, being placed far enough apart to ensure uniform stressing above and below the hole at the centre. The load was in each case so adjusted that, if it were uniformly distributed over the transverse section containing the centre of the hole, the stress would be 1000 kg. per sq. cm. Stresses are deduced from strain measurements by an optical apparatus [see Abstract No. 1488 (1912)], the datum length being 8·3 mm., and readings being correct to 5 %. Owing to the curvature of the stress lines round the hole, it is not sufficient to measure only axial strains at a number of points along the central plane; strain measurements at right angles have to be made simultaneously. If $s_1$ and $s_2$ are the longitudinal and lateral strains measured, E = Young's modulus, $\sigma$ = Poisson's ratio, $f_1$ and $f_2$ = longitudinal and lateral stresses at the point, then—

$$f_1 = E\sigma(\sigma s_1 + s_2)/(\sigma_2 - 1), f_2 = E\sigma(s_1 + \sigma s_2)/(\sigma^2 - 1).$$

Both stresses are tensile. In each case the area under the diagram of longitudinal stress plotted on the section should equal the rectangle contained by the sectional area and the "mean stress" of 1000. It is found that the agreement is rather erratic, the error varying from − 1·7 % to + 12·8 %. In general the stress falls from a very sharp maximum at the edges of the hole, but with smaller holes the curve descends very gently after passing the mean stress line, and with large holes the curvature varies but little. The magnitude of the maximum varies irregularly from 2·13 to 2·85 of the mean, but appears to be independent of the diam. of the hole. The minimum stress decreases steadily from 87·2 % to 52·0 % of the mean with increase of diam. from 15 mm. to 70 mm. E. J. S.

9. *Law of Equivoluminal Oscillations in Metals.* **W. Peddie.** (Engineering, 94. p. 550, Oct. 18, 1912. Paper read before the British Assoc., at Dundee, 1912.)—The case considered is that of the torsional oscillations of a wire, which is the simplest condition accompanied by no change of volume. The oscillations are set up in the wire, less than 1 ft. long, by means of a torsion head, so that no pendulum vibrations are set up. The load at the free end is a brass ring with a number of brass pins arranged at equiangular distances in a circle on its lower face. As the ring oscillates in a horizontal plane, the pins make contact with radial mercury pools in an ebonite disc. The angular interval of the pools is different from that of the pins, so that the Vernier principle is employed. The making contact at various stages of an oscillation actuates needles by means of electromagnets, perforating a travelling squared card. Thus chronographic records are obtained of the instants of attainment of successive angular positions at intervals of 2°. Tests of iron and steel, where Hooke's law is closely obeyed, show that vibrations are simple harmonic. Isochronism is lost with viscous metals such as copper, zinc, and lead, a large oscillation having a longer period than a smaller one. The time of inward swing from the max. angular displacement to the centre is distinctly longer than the time of swing to the next maximum. The displacement-time curve exhibits a point of contrary flexure corresponding to the position of set. If a simple harmonic curve be taken with its point

of contrary flexure coinciding with the position of set, and its maximum coinciding with the maximum beyond that position of set, then it is found that the experimental return curve practically coincides with the former through all phases up to a displacement equal to that of the position of set and on the other side of the zero point. A rapid deviation occurs in the remainder of the outward swing, an earlier maximum being attained at a smaller displacement. It is thus found that the simple harmonic law holds for the greater part of a semi-oscillation even when the viscosity is so great as to reduce the amplitude to one-third in a semi-oscillation. This correspondence was unexpected, and afforded an interesting comparison with J. Wiedemann's theory that the loss of energy in a vibrating wire is due to work of distortion in passing from one to another position of set. E. J. S.

10. *Investigation of Stresses in Riveted Joints and their Effect in causing Tearing at the Holes.* **C. Bach** and **R. Baumann.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1890–1895, Nov. 23, 1912. Communication from the Materialprüfungsanstalt d. Kgl. Techn. Hochschule, Stuttgart.)—The force, Q, with which the rivet holds the plates together is determined by carefully measuring the overall length in the joint, then turning the plates away in a lathe so that the rivet falls out. Q being now released, the rivet shortens by a measurable amount, which is reduced in proportion to the length of the shank. The influence of the strengths of the heads introduces a small error into the calculation of Q on this basis, which is incommensurable but negligible when accidental variations of elasticity, etc., are remembered. The use of a red-hot screw and screwed head in place of a rivet, equivalent to zero pressure in the ordinary machine, gave a stress for Q near the lower elastic limit of the rivet, whilst moderate pressures in the press give about the same figure. The customary high pressures give a small falling-off of Q due to the severe overstraining of the plates. With well-bedded flat plates the cooling of the rivets suffices to give a good joint. The force employed should only be just sufficient to form well-shaped heads and to press the plates together if they have a tendency to spring apart. For the rivets used, 2·8 cm. diam., a force of 40,000 to 50,000 kg. causing a stress of 6000 to 8000 kg. per sq. cm. of rivet is found to be ample. To avoid the detrimental effects of excessive pressures it is desirable to make the plates bed together well, *e.g.* in boilers by carefully bending to the same radius. High pressures cause the material of the plates to flow under the rivet-heads. The latter sink in and the plates spring apart near the caulking edges. The stresses due to overstraining combined with thermal stresses cause radial cracks to start from the holes: these are plainly seen in photographs reproduced. The period during which steady pressure is applied is found to be of importance only when the plates tend to separate. In the latter case 1 minute is found to be sufficient (with the die not cooled), to give the rivet sufficient strength to draw the plates together. It is found that the holding power is increased by increasing the length of the rivet. This is explained from the fact that the rivet-heads take up a larger proportion of the axial strain in short rivets than they do in long. The best result is obtained with a stress near the lower elastic limit of the rivet, when the length is made equal to 3 diameters. With greater lengths overstraining follows in the plates. Tests were made of rivets only heated at one end for closing the heads. The holding stresses are found to be of the same order as with wholly heated rivets. But several heads broke away from the shanks and there were evidences of severe local overheating strains. The evil effect of local heating was shown by breaking tests

on bars of the rivet material. Bars which had cooled after local heating were uniformly weaker than those heated throughout. It was particularly noticeable that the former showed only 19·9 % elongation, as compared with 28·2 % by the latter. The locally heated rivets, by unequal contraction, also caused severe damage to the plates. E. J. S.

11. *Absorption of Gravitation.* **W. de Sitter.** (Observatory, 35. pp. 387–398, Nov., 1912.)—The writer gives a review of a pamphlet recently published by K. F. Bottlinger, of Munich, on the "Theory of Gravitation and Motion of Worlds," in which the possibility of an outside influence on gravitation is shown to be within the bounds of probability. Bottlinger finds that there is an absorption or extinction of gravitation when a material body intervenes between two bodies whose mutual action is being considered, *e.g.* the gravitational pull of the sun on the moon may be diminished during a lunar eclipse by the intervention of part of the earth. A short outline of the analysis is given, with curves, showing the interesting nature of the perturbation found, this being in the form of an irregular curve having alternate maxima and minima with approximate periods of 18 years. Superposed there appears to be a longer period, possibly connected with the known cycle of 278 years. Some work on the same subject by Sitter is given in comparison. C. P. B.

12. *Exit of a Projectile from a Mortar.* (U.S. Artillery, Journ. Sept.–Oct., 1912. Engineering, 94. pp. 718–719, Nov. 22, 1912.)—Six photographs taken by the Department of Enlisted Specialists, U.S. Coast Artillery School at Fort Monroe, illustrate the exit of a projectile from a mortar, and the peculiar smoke cloud, which the projectile overtakes and which sometimes encircles the gun like a ring. The photographs evidently represent not successive stages of the same discharge, but successive moments of different discharges, though this is not stated in the original report. H. B.

13. *Resistance to Air Flow in Pipes.* **A. H. Gibson.** (Engineering, 94. p. 708, Nov. 22, 1912.)—Mentions previous paper by the author and J. H. Grindley [see Abstract No. 554 (1908)] which gave results at variance with commonly accepted laws. It appears that any formula of the form $dp = flv^2/2gm$ can only hold when $f$ is varied to suit the physical condition of the interior surface of the pipe and its diameter as well as the mean pressure, temperature, and velocity of flow. The theory of dimensions gives an equation of the form $dp = k(p^{n-1} . v^n . \mu^{2-n})/[a^n . d^{3-n} . (c\tau)^{n-1}]$, where $k$ and $a$ are numerical constants, $p$ and $v$ are the mean absolute pressure and velocity in the pipe, $\mu$ is the viscosity and $\tau$ is the absolute temperature; $c$ is from the equation $pV = c\tau$ and equals 11·9 when unit mass is 1 lb., $d$ is the pipe diam. and $n$ is a numerical index. The experimental results of Riedler and Gutermuth, of Brix, Stockalper, and of the author are analysed and show good agreement with the dimensional equation above. The index $n$ may in the case of ordinary cast-iron pipes be assumed to have the values 1·83, 1·81, 1·79, 1·78, 1·77 when the diam. is 3, 5, 7, 9, 12 in. respectively, and for all cases of flow where the air is at atmospheric temperature (about 65° F.) the drop in pressure is very nearly $dp = 0{\cdot}00000125(p^{n-1} . v^n . l)/(6{\cdot}8^n . d^{3-n})$ lbs. per sq. in. H. S. R.

14. *Steady and Turbulent Motion in Gases.* **J. J. Dowling.** (Roy. Dublin Soc., Proc. 13. 26. pp. 375–398, Nov., 1912.)—A new method of investigating

the varying conditions of flow of gas through a tube is described. The gas passing through the tube is ionised by the action of radium bromide at a certain point, the rest of the tube being screened from the rays by a block of lead. The gas passes into an insulated metal cylinder connected to the negative pole of a battery of about 200 volts. A wire passing through the side of the cylinder and insulated from it is bent so as to lie on the axis; its other end is connected to one pair of quadrants of a Dolezalek electrometer, the other pair of quadrants and the positive pole of the battery being earthed. The charge acquired by the wire is a measure of the ionisation of the air reaching the cylinder. Plotting curves for the variation of this residual conductivity with the rate of flow of gas through the tube, it is found that the conductivity at first increases smoothly (as would be expected for stream-line flow) with the velocity, but at a certain velocity for any particular tube there is a well-pronounced discontinuity. After this occurs the curve may continue to show an increase of conductivity with velocity, as before, or, in some cases, a decrease. This discontinuity corresponds to the commencement of turbulent flow. Various glass and copper tubes were experimented with. For the glass tubes the mean value of the constant $K = \rho V_c d/\eta$ is 2481; $\rho$ being the gas density, $\eta$ its coefficient of viscosity, $V_c$ the critical velocity, and $d$ the diameter of the tube. Hence Reynolds' formula becomes $V_c = 1240\eta/\rho a$, where $a$ is the radius of the tube. The corresponding result for copper tubes is $V_c = 1560\eta/\rho a$. The value of the constant is in each case higher than Reynolds' value for water, but it is remarkable that the difference is only, at most, about 50 per cent. The dependence of the critical velocity on density and viscosity was also investigated, $CO_2$ being used. In several cases a second critical stage was discovered, the curves showing two marked discontinuities. The relation between the second critical velocity and the tube diam. is $V_c = 26{\cdot}6\,(d + 0{\cdot}6)$, the points lying very close to this straight line. Three possible explanations of this second critical velocity are suggested, the most probable of these being that it is due to something in the nature of "slip." This view is supported by experiments on the skin friction of air flowing in tubes. A. W.

**15.** *Laws of Fluid Flow.* **V. Kaplan.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1578–1586, Sept. 28, 1912.)—Recent literature on fluid flow shows the tendency to treat two-dimensionally problems formerly treated one-dimensionally. Even the velocity potential is imperfect to describe actual phenomena, and the current method of estimating frictional losses as a percentage of the total head is not without fault. The author discusses mathematically the flow of liquids, especial regard being paid to the effects of viscosity and boundary friction. Instead of the Newtonian assumption for viscosity and its consequent equation $\tau = \mu \,.\, dv/dz$ the author uses $\tau = \mu' zv \,.\, dv/dz$, where $\tau$ = shear stress, $\mu$ and $\mu'$ are viscosity constants, and $z$ is the co-ordinate perpendicular to the shear planes. This second equation seems to fit practical results better than the first. The author applies it to the flow in a parallel canal and draws lines of force and isotachs or isovels for a rectangular section. The energy increment from layer to layer increases as the boundary becomes nearer, except at the boundary where it is zero. It increases with the length and roughness of the canal but decreases as the mean flow increases. An analogy from the mathematical flow of heat is considered, and the similarity of temperature and velocity distribution pointed out. Experiments are then described which support the theory. H. S. R.

16. *Motion of a Viscous Fluid under a Rotating Plate.* **H. Sanders.** (Deutsch. Phys. Gesell., Verh. 14. 16. pp. 799–805, Aug. 30, 1912. Extract of Inaug. Dissertation, Erlangen, 1912.)—The liquids dealt with were paraffin and distilled water; the circular disc was rotated on the surface of the liquid at various uniform speeds by means of an electric motor; and the shearing deformation of the liquid was investigated by means of a number of thin straight metal rods secured at their middle points by elastic threads, as in Reiger's experiments [Abstract No. 307 (1910)]. Curves are reproduced showing the effect of increased angular velocity of the plate, of depth of liquid, of the dimensions of the rods, and of the width of the containing vessel. Turbulent motion is also considered. At small angular velocities of the plate it is shown that a linear relation exists between the velocities of the particles of the fluid and their distance from the bottom; but for large velocities complicated results are obtained which are not altogether explained by the assumption of the commencement of turbulent motion. A. W.

17. *Formation of Sand Dunes.* **P. Hahmann.** (Ann. d. Physik, 39. 3. pp. 637–676, Oct. 15, 1912. Inaug. Dissertation, Bonn.)—An investigation of the formation of ripple-marks, sand dunes, etc., by uniform streaming of water or wind. The first part deals with earlier researches; the second gives the results of the author's own experiments, and the last discusses the subject theoretically. The results may be summarised as follows:—(1) The distance apart of ripple-marks increases proportionally with the velocity of the water which forms them. (2) The distance also increases with the size of the grains, but whether the relation is linear or not is not decided. (3) The distance apart increases with increasing temperature, apparently being proportional to it. (4) The distance decreases with increasing concentration of the salt solution. With higher concentrations the distance decreases more rapidly. Effects (3) and (4) are shown theoretically not to be due to density variations of the fluid, but to internal friction. (5) The investigations with air currents also gave an increase of the distance apart proportional to the velocity. (6) With water it was found that the distance apart increased with the size of the grains, but with wind the reverse was the case. A theoretical explanation of this is given, based on Helmholtz's eddy theory. A. W.

18. *Foundation of a Theory of Matter.* **G. Mie.** (Ann. d. Physik, 39. 1. pp. 1–40, Sept. 5, 1912.)—Highly analytical paper in continuation of previous one. The present communication is concerned with electron problems and the point singularities of the fields (*Knotenstellen der Felder*). One part of the analysis leads to the conception of alternately positively- and negatively-charged concentric spherical shells like the layers of an onion. Between two shells, near the zero equipotential surface, there is a more or less extensive region in which the electric atmosphere is extremely rare, and in which a field exists as in a concentric spherical shell condenser. Near the centre of the system the *onion layers* crowd closer and closer together, and electric density, potential, and field between two shells all increase without limit. [See Abstract No. 782 (1912).] E. H. B.

19. *Theory of Relativity.* **R. D. Carmichael.** (Phys. Rev. 35. pp. 153–176, Sept., 1912.)—In the theory of relativity the word *postulate* has been used in the sense in which one is accustomed to employ the term *law of nature.* The present paper contains an analysis of the postulates of relativity. It was

undertaken in order to ascertain on just which of the postulates certain fundamental conclusions of the theory depend. The importance of this may be seen as follows. Some of the conclusions of relativity have been attacked by those who admit just the parts of the postulates from which the conclusions objected to can be derived by purely logical processes. It is here sought to establish some of the most fundamental and most readily accessible conclusions of the theory on the smallest possible foundation from the postulates. This plan of treatment, instead of giving rise to more complicated arguments than those hitherto usually employed, has had the opposite effect of leading to increased simplicity both in the notions which enter and in the arguments by which proofs are reached. In the early part of the work it was found that some of the most striking conclusions of the theory depend on only a part of the postulates. To bring this fact prominently into view is to put the whole subject in a clearer light where we may see better the interactions of its parts and its general relations to the whole body of scientific and general knowledge.

Writers on relativity have usually stated two postulates only, but have tacitly, and in some cases perhaps unconsciously, made further assumptions. These are here stated at the outset, and then other postulates and theorems obtained as indicated below, the whole forming a simple introduction to the entire subject.

*Postulate $H_1$.*—Space is homogeneous and three-dimensional.

*Postulate $H_2$.*—Time is homogeneous and one-dimensional.

*Definition of S.*—Consider any set of things consisting of objects and any kind of physical quantities whatever, each of which is at rest with reference to each of the others. Suppose these objects include clocks and rules, *i.e.* time and length measures. Such a set of objects and quantities, at rest relatively to each other, together with their units for measuring time and length, are called a *system of reference*, and will be denoted by S; or, if there are several, by $S_1$, $S_2$, etc. Further, it is assumed that the units of any two systems $S_1$ and $S_2$ are such that the same numerical result will be obtained in measuring with the units of $S_1$ a quantity $L_1$ and with the units of $S_2$ a quantity of $L_2$, when the relation of $L_1$ to $S_1$ is precisely the same as that of $L_2$ to $S_2$.

*Postulate M.*—The unaccelerated motion of a system of reference S cannot be detected by observations made on S alone, the units of measurement being those belonging to S.

*Postulate R′.*—The velocity of light in free space, measured on an unaccelerated system of reference S by means of units belonging to S, is independent of the unaccelerated velocity of the source of light.

*Theorem I.*—The velocity of light in free space, measured on an unaccelerated system of reference S by means of units belonging to S, is independent of the direction of motion of S. (MR′.) (The letters in brackets after any theorem here and hereafter indicate the postulates on which it is based and from which and the H's it may be derived by purely logical processes. The postulates $H_1$ and $H_2$ are not separately inserted after each theorem as they underlie all.)

*Postulate R″.*—The velocity of light in free space, measured on an unaccelerated system of reference S by means of units belonging to S, is independent of the absolute value of the velocity of S.

*Postulate R* consists of the combination of R′ and R″ and thus often affords an abbreviated reference.

*Theorem II.*—The velocity of light in free space, measured on an unaccelerated system of reference S by means of units belonging to S, is independent of the velocity of S. (MR.)

The second postulate of relativity has usually been stated in a form different from that given above in R′ and R″ or R. In fact, the truth of Theorem I. has often been taken as part of the *assumption* in this postulate notwithstanding that I. can be derived from M and R′. Now it is precisely the supposed assumption of I. that has given most difficulty to some persons. It is believed part of this difficulty will disappear in view of the fact that I. is here demonstrated from M and R′, which are probably accepted by those who found difficulty in Theorem I.

*Postulate V.*—If the velocity of a system of reference $S_2$ relative to a system of reference $S_1$ is measured by means of the units belonging to $S_1$, and if the velocity of $S_1$ relative to $S_2$ is measured by means of the units belonging to $S_2$ the two results will agree in absolute value.

This velocity is called the *relative velocity* of the two systems and its direction line the line of *relative motion.*

*Postulate L.*—If two systems of reference $S_1$ and $S_2$ move with unaccelerated relative velocity, and if a line segment *l* is perpendicular to the line of relative motion of $S_1$ and $S_2$ and is fixed to one of these systems, then the length of *l* measured by means of the units belonging to $S_1$ will be the same as its length measured by means of the units belonging to $S_2$.

The usual relations of relativity as to measures of time and space in two systems are then obtained. E. H. B.

20. *Surface Tension of Solutions and Suspensions of Soap.* **F. Bottazzi.** (Accad. Lincei, Atti, 21. pp. 865–878, Oct. 18, 1912.)—The surface tension of water, in which is suspended sodium or potassium stearate, does not differ from that of pure water. The gradual addition, drop by drop, of N/20 NaOH to a solution of sodium oleate first decreases its surface tension to a minimum, the partial suspension being transformed into a perfect solution; further addition of NaOH slightly increases the surface tension. Addition of N/50 NaOH to a dialysed 2 % solution of potassium oleate decreases the surface tension steadily until 40 drops have been added per 15 c.cm. The surface tensions of dialysed solutions of sodium and potassium oleates are diminished by the addition of N/20 KOH and NaOH respectively, minima being reached, beyond which the addition of alkali increases the surface tension. If after the surface tension has thus increased N/50HCl is added, it again falls to a minimum, and then commences to rise with further addition of HCl. The addition of N/1NaOH to a 6 % solution of sodium oleate first increases the surface tension, which after reaching a maximum, gradually falls, the solution remaining perfectly limpid, but becoming very viscid. The results are attributed to the effect of NaOH in first retarding hydrolytic dissociation, and then in tending to precipitate soap. W. H. Si.

21. *Instrument for Registering Rectangular Co-ordinates.* (Pat. No. 234,868 of 1910. Zeitschr. Instrumentenk., Beib. 19. p. 207, Oct. 1, 1912.)—Describes, with sketch, the apparatus, which is made by Hartmann and Braun. A. W.

22. *Theory of the Anschütz Gyroscopic Compass.* **O. Martienssen.** (Zeitschr. Instrumentenk. 32. pp. 309–321, Oct., 1912.)

23. *Effect of Temperature and Chemical Nature of Liquids on the Viscosity for Turbulent Flow.* **W. Sorkau.** (Phys. Zeitschr. 13. pp. 805–820, Sept 1, 1912.)

24. *Diffusion in Solids.* **C. H. Desch.** (Chem. News, 106. pp. 153–155, Sept. 27; 168–170, Oct. 4; 178–181, Oct. 11, and pp. 191–193, Oct. 18, 1912 Report presented to the British Assoc. at Dundee. Engineering, 94. p. 583 Oct. 25, 1912. Abstract.)—The subjects discussed are: Diffusion in Glasses and Devitrification; Electrolysis of Glass and Porcelain; Diffusion of Gases through Metals; Passage of Liquids through Metals; Solid Diffusion in Metals; Cementation and Decarburisation of Iron; Segregation and Recrystallisation; Influence of the Amorphous Modification in Metals; Electrolysis of Crystalline Solids; Diffusion in Minerals; Diffusion in Artificial Crystals; Diffusion in Colloidal Gels; Liesegang's Phenomena. Those who are interested in the topics discussed are advised to consult the original report. T. M. L.

25. *Application of Kinematography in Shock Tests.* **W. Hőniger.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1501–1505, Sept. 14, 1912.)—The author has applied a moving photographic film to the determination of the force absorbed in impact tests. F. C. A. H. L.

26. *Hysteresis of Suspensions.* **O. Venzke.** (Ber. über d. Tätigkeit d. Kgl. Preuss. Meteorol. Inst. i. J. p. 129, 1912. Zeitschr. Instrumentenk. 32. pp. 330–331, Oct., 1912. Abstract.)—Discusses the creep or after-working phenomena of fibre suspensions and gives detailed instructions for reducing these disturbances to a minimum. E. H. B.

27. *The Brownian Movement and the Size of the Molecules.* **J. Perrin.** (Chem. News, 106. pp. 189–191, Oct. 18; 203–206, Oct. 25, and pp. 215–217, Nov. 1, 1912. Paper read before the Royal Inst., Feb. 24, 1912.)

28. *Resistance to Motion of Body in Fluid.* **T. v. Kármán.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 5. pp. 547–556, 1912.)—Mathematical paper dealing with the mechanism of this fluid resistance. E. H. B.

29. *Longitudinal and Transversal Masses.* **P. Frank.** (Ann. d. Physik, 39. 3. pp. 693–703, Oct. 15, 1912.)—Derives formulæ for the masses at high speeds by energetics. E. H. B.

30. *Evaporation from the Soil and Plants.* **A. Müntz.** (Comptes Rendus, 155. pp. 519–521, Sept. 9, 1912.)—Periods of long rainfall tend to persist as in 1910 and 1912. At the *Station de Chimie Végétale* at Bellevue 218 m.$^3$ of water evaporated from the soil per hectare during the month of July, 1910; the evaporation from a field of lucerne was 803 m.$^3$ and the rainfall 697 m.$^3$ per hectare in the same period. In Aug., 1912, there were 894 m.$^3$ of rainfall and 900 m.$^3$ of water evaporated from the lucerne field per hectare. The evaporation from the plants is thus much stronger than from the soil. It has also been observed that a soil from which strong evaporation is taking place is 2° or 3° C. colder than other soil, and the air which circulates through the leaves of the lucerne is 3° colder than the air above the plants. H. B.

31. *Seismological Investigations.* **J. Milne.** (Engineering, 94. p. 551, Oct. 18, 1912. Abstract of paper read before the British Assoc. at Dundee.)—The paper forms the 17th report of the B.A. Committee on Seismological Investigations, and contains a catalogue of all the earthquakes of the last 11 years. The author's investigations show that the amplitudes of the

angular displacements in earthquake movements first decrease uniformly with the distance from the origin up to a distance of 80°, then less rapidly, and remain almost constant beyond 120°. Periods of megaismic activity are followed by periods of quiescence, large groups of earthquakes being succeeded by periods of rest of from 15 to 80 days. There are no indications of seasonal variation, but there is evidently a connection between the geographical distribution of megaisms and the thermometric gradients. In general there is four times the activity beneath the cold waters of some oceans that there is beneath the continents. Unfortunately there are few records as to temperature gradients, and hardly any for the soil beneath the sea. Probably heat is lost at ocean floors about 3½ times as fast as at continental surfaces. From a comparison of the behaviour of cooling slag with volcanic dykes and fissures, Milne suggests that, with our earth, it was not the nucleus which contracted to leave a shell to follow downward, but a forming shell which contracted, and by its sudden grip on the unshrinking nucleus fractured itself. A. D. R.

32. *Earth-tides.* **T. Shida.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 13. pp. 273–275, July, 1912.)—The author corrects for the tidal displacement of the observing station the value given in a previous paper [see Abstract No. 1330 (1912)] for the lunar disturbance of the earth's potential. A. D. R.

33. *Orientation of Photographic Equatorials.* **E. Esclangon.** (Comptes Rendus, 155. pp. 693–696, Oct. 14, 1912.)—Mention is made of the possibility of error in the making of region photographs with a photographic equatorial by merely following on a guiding star. If a small area round the guide star is considered, this area will be continuously deformed by differential refraction to a slight extent, depending on the altitude. An equation is given for calculating orientations which will reduce this deformation. C. P. B.

34. *Mass of Saturn's Satellite, Titan.* **H. Samter.** (Preuss. Akad. Wiss. Berlin, Ber. 46. pp. 1051–1059, 1912.)—A review is given of results from previous calculations, and a new computation embodying recent determinations of position. The resulting value is $m^{-1} = 4172 \pm 58$. C. P. B.

35. *Elements of Eclipsing Variable Stars.* **H. N. Russell.** (Astrophys. Journ. 36. pp. 133–155, Sept., 1912.)—In illustration of the methods proposed in former papers [see Abstract No. 1664 (1912)] details are given of the computation of the elements of the three eclipsing variables, W Delphini, W Ursæ Majoris, W Crucis. C. P. B.

36. *Structure of Upper Solar Atmosphere.* **H. Deslandres.** (Comptes Rendus, 155. pp. 743–749, Oct. 21, 1912.)—In continuation of a former paper [see Abstract No. 1822 (1912)] the author gives a detailed discussion of various forms of solar disturbance photographed with the spectroheliograph at Meudon. From the examination of many plates it appears to be certain that alignments are elevated masses of material, and in general they show as prominences when projected at the solar limb. For the smaller prominences this connection cannot be completely established until more powerful apparatus with a larger image is available. Evidence is given to show the importance of a study of these features in relation to the solar

atmospheric circulation. In explanation of the phenomena the effect of positive electrification is considered, with the added influence of the magnetic field which is now admitted to exist in many regions of the solar surface. This view explains without difficulty the complicated spiral and contorted structures presented by prominence matter during eruptions. From the opposite deviations of the matter of the filaments and that of the general upper atmosphere it appears that these have opposite electric charges, and we thus have also to consider the effect of an electric as well as a magnetic field. An interesting point is that on the above view the solar matter should be elongated from pole to pole; measures of the solar diameters, polar and equatorial, have at various times given evidence of such difference, but it has been so small that its reality could not be satisfactorily accepted. Thinking that any such effect might reasonably be more shown on the chromosphere. the author had a series of measurements specially made, and it was found that there was a systematic variation in the thickness of the chromosphere, the polar depth being greater than the equatorial; further, the difference was found to be variable from one place to another, and appeared greater for the southern hemisphere. C. P. B.

37. *Systematic Motions of Sun-spots.* **Hirayama.** (Coll. Sci. Journ. Imperial Univ., Tokio, Vol. 32. No. 7. Nature, 90. p. 178, Oct. 10, 1912. Abstract.)—From an analysis of the sun-spot motions given in Greenwich, Carrington, and Spörer catalogues, evidence is found of two sun-spot drifts. It is suggested that this may explain the distribution of sun-spots with different rotation periods. C. P. B.

38. *Total Solar Eclipse at Vavau, April* 28, 1911. **A. L. Cortie.** (Roy. Soc., Proc. Ser. A. 87. pp. 298–301, Sept. 19, 1912.)—The programme of observations organised by the Joint Permanent Eclipse Committee, consisted of (*a*) photographs of the corona on large and relatively small scales for coronal detail and extension of the streamers, (*b*) photographs of the spectrum of the corona and of the lower chromosphere. The weather conditions were very bad, the sun being surrounded with dense cirro-stratus clouds. With the 20-ft. coronagraph two plates show the lower corona in the immediate neighbourhood of the moon's limb, prominences being shown in position angle 240°-258°, near the point of third contact. With the 84-in. coronagraph one good impression was obtained with an exposure of 25 secs. before third contact, the corona extending about one-half a lunar diameter, and several polar rays being visible. Only one spectrum photograph is of value, secured just before and at the time of the second flash, with the prismatic camera, and shows the hydrogen series from $H_\alpha$ to $H_\theta$. C. P. B.

39. *Helium and Coronium.* **A. A. Buss.** (Observatory, No. 458. pp. 371–378, Oct., and p. 404, Nov., 1912.)—Observations of helium absorption by the dark $D_3$ line have been readily discernible over regions of faculæ, but the author has found that on occasions of best definition the absorption may be seen at almost every point on the solar disc. The difficulties often found in seeing it are probably mainly due to motion of the image over the slit of the spectroscope, thus causing an integration of the spectrum of neighbouring parts of the sun. With regard to the corona the suggestion made by Wood some time ago is supported, that the phenomenon is one of fluorescence and not due to direct radiation. The author goes further and doubts the solar origin of the green line at 5808, thinking the green halo producing it may have a separate existence from the radiated outer coronal streamers. . P. B.

40. *Radium and the Chromosphere.* **S. A. Mitchell, J. Evershed.** (Astronom. Nachr. No. 4600. Observatory, No. 458, pp. 357–362, Oct., 1912. Abstract.)—Mitchell has examined his eclipse chromospheric spectra and compared the results with the spectrum of radium given by Exner and Haschek. After discussing the various types of coincidence, which are given in tabular form, the conclusion is given that there appears to be no reason for ascribing any of the lines concerned to radium. The chief cause of the different opinions expressed by other workers would appear to be due to the different dispersive powers used, rendering ambiguous the correct allocation of the components of close groups of lines. Evershed points out that the apparent identification of radium lines with chromospheric lines becomes less probable when more determinations of eclipse spectra are used in the discussion. Detailed analysis is given of the alternative origins for each of the lines in question. Special mention is made of the Ra line near λ5818·9, which region is almost blank in the solar spectrum, and might furnish a crucial test of the presence or absence of radium in the chromosphere. It is concluded that neither radium nor the emanation can be detected in the chromosphere by their spectra. **F. W. Dyson.** (Observatory, 35. pp. 402–404, Nov., 1912.)—Replying to the views expressed by Mitchell and Evershed, Dyson states that he attaches more importance than they do to the close correspondence of lines in the spectrum of radium with lines in the chromospheric spectrum. He also regards the chromospheric spectrum as not having a very close relationship to the solar (Fraunhofer spectrum), its agreement with metallic spark spectra being much closer because of the correspondence of the intensities of the lines. The question of close coincidences must not be taken alone, one of the additional criteria of value being the relative intensity of the spark lines of the elements in question, and especially if they be enhanced lines or otherwise. Dyson admits difficulty in accounting for the absence of any line at λ4826·10 in Mitchell's spectrum; this and the presence of lines at λ4682·12 (Ti) and λ4682·58(γ), whereas the radium line is λ4682·41, somewhat weakens the case for radium. He hopes the line at 5818·9 mentioned by Evershed will be looked for at subsequent eclipses. C. P. B.

41. *Balloon Shadows during Solar Eclipse.* **A. Wigand** and **E. Everling.** (Deutsch. Phys. Gesell., Verh. 14. 15. pp. 748–757, Aug. 15, 1912.)—Photographs of the shadow of a balloon were taken during an ascent from Bitterfeld on the occasion of the partial solar eclipse, April 27, 1912. Diagrams are given showing the development of the shadow form by taking loci of projected shadows from each point of visible crescent, and three reproductions of the photographs are included. C. P. B.

42. *Determination of Solar Motion.* **W. Dziewulski.** (Acad. Sci. Cracovie, Bull. 7a. pp. 811–832, July, 1912.)—The elements of the solar motion are determined by Bravais' method, using parallaxes given by Kapteyn, Weersma, Pritchard, and Flint, radial velocities by Campbell, Küstner, Frost and Adams, Bélopolsky, Slipher, Newall, and Lord. Several different values of the velocity and co-ordinates of the apex are given, depending on the groups of observations employed. C. P. B.

43. *Probable Identity of Comet 1912(b) with Tuttle's Comet.* **G. Fayet.** (Comptes Rendus, 155. pp. 808–810, Oct. 28, 1912.)—The provisional elements of the new comet 1912(*b*), calculated by the writer with Schaumasse, were

very similar to the accepted elements of Comet Tuttle, whose return was expected about this time. The differences between the two sets of elements are probably due to perturbations of the comet since its last apparition in 1899; in 1900 a close approach was made to Jupiter. C. P. B.

**44.** *Spectrum of Comet Gale* (1912*a*). (Astronom. Nachr. No. 4608. Nature, 90. p. 288, Nov. 7, 1912. Abstract.)—Photographs of the spectrum of Gale's comet (1912*a*) at the Hamburg Observatory showed bands at λλ387, 474, 568. The continuous spectrum was relatively faint, but extended from λ387 to λ568. C. P. B.

**45.** *Parallax and Proper Motion of Nova Lacertæ.* **Balanowsky.** (Nikolai-Hauptsternwarte zu Pulkowo, Mitt. No. 52. Nature, 90. p. 178, Oct. 10, 1912. Abstract.)—Sixteen plates of the region of Nova Lacertæ were taken during the period Jan. 4, 1911, to Feb. 19, 1912. The values determined for parallax and proper motion were so minute as to indicate that these quantities were practically zero. C. P. B.

**46.** *Spectrographic Observations of Algol.* **A. Bélopolsky.** (Acad. Sci. St. Pétersbourg, Bull. 15. pp. 937–938, Nov, 1, 1912.)—From determinations of the radial velocity of the variable star system of Algol ($\beta$ Persei) during the interval 1897–1911, the correction to the ephemeris time of minimum is determined. This is compared with the corrections determined by other means—the selenium photometer of Stebbins and the ordinary photometric methods. The values are greatest in amount for the selenium photometer (—76 m.), less for the ordinary methods (—70 m.), and least of all for the spectrographic method (—56 m.). It is pointed out that the three methods differ in that they employ different ranges of energy spectrum: the selenium photometer specially the red rays, the ordinary photometer the general visual rays, and the spectrograph utilising the violet rays. C. P. B.

**47.** *Determining Angular Diameters of Stars by Elliptically-polarised Light.* **S. Pokrowsky.** (Astrophys. Journ. 36. pp. 156–168, Sept., 1912.)—The method proposed is based on the consideration that between two rays arriving at any two points from any element of the surface of a distant source of light, there will always be a difference of phase depending on the distance between these points. For the various elements of the surface of the star this difference will have different values, from zero up to a certain limit determined by the magnitude of its angular diam. If we polarise all the rays which emanate from the star towards two points not very near together, and if we then superimpose them after turning the plane of polarisation of one of the bundles of rays through 90°, we shall obtain in general elliptically-polarised rays, if the difference of path be of the same order of magnitude as the wave-length of light. In the case of an infinitely small diam. the polarisation will be rectilinear. The alteration of 90° is made by interposing a half-wave plate in the path of one of the rays. The group of plane waves elliptically polarised are then passed through a doubly-refracting prism, and then observed by a telescope. An equation is derived from which the diam. of a star may be found if the distance between the two screen openings is known, and also the ratio of the intensities of the two polarised images. Two types of stellar interferometer adapted to this method of observation are then outlined. C. P. B.

## LIGHT.

**48.** *Long-focus Microscope. Study of Oxidation and the Phenomena of Development of Grain Joints and Division of Grains of Metals under Influence of Heat.* **F. Robin.** (Bull. Soc. d'Encouragement, 118. pp. 204–231, Aug.–Sept.–Oct., 1912.)—With the object of studying the changes occurring in metals at various temperatures, the author has designed a microscope with a long frontal distance. Normally, such a microscope can only give low magnifications, but this difficulty has been removed by placing a double concave lens just outside the focus of the objective. By this means it is possible to obtain defined magnifications of 200 diams. with a frontal distance of 5 cm., which permits of the examination of metal sections during heating and cooling. The author has studied the rate of oxidation of the constituents of steel and other alloys at various temperatures, and has shown that at high temperatures a sort of local or corrosive oxidation takes place. At certain temperatures the joints of pure metals and solid solutions are developed quite sharply on heating, and at higher temperatures these grains split up into secondary grains. F. C. A. H. L.

**49.** *New Acuteness-of-Vision Photometer.* **R. Pauli.** (Zeitschr. Instrumentenk. 32. pp. 294–297, Sept., 1912.)—The author describes a new form of acuteness-of-vision photometer. A white wedge is illuminated by the lamp to be tested, and this surface is observed through an eyepiece. Between the eye and the illuminated white area is placed a glass screen on which a diagram composed of very fine lines (0·007 mm. in diam.) is marked. The observer moves the photometer until the network of lines is just visible. Letters and figures have purposely been avoided, as the observer is apt to remember them and fancy that he can read them when he really cannot. The lines can be rotated so that the observer does not know their position, and is therefore not prejudiced by knowing exactly what he is going to see. In comparing two lamps, the observer merely moves the photometer backwards and forwards until the lines become perceptible and notes the distance from the source. The method is said to give satisfactory results, but allowance has to be made for the effect of adaptation on the eye.

J. S. D.

**50.** *Absorption of Light in Solutions of Benzene and its Derivatives at Low Temperatures.* **J. de Kowalski** and **E. Banasinski.** (Acad. Sci. Cracovie, Bull. 5a. pp. 416–435, May, 1912. Archives des Sciences, 34. pp. 216–233, Sept., 1912.)—The absorption spectrum of benzene shows fifteen bands. The "principal group" of six bands are equally marked at ordinary temperatures and at low temperatures. The second group consists of two bands which resemble the principal bands in their positions and properties, but one is sharp only at atmospheric temperatures and the other at low temperatures. Finally, there is a group of seven bands which are clearly visible only at the temperature of liquid air. The positions of the heads of the bands of the principal series are expressed accurately by the formula $1\lambda = 3852 - 91n$. A further regularity is seen in the fact that the heads of the bands of the solution at $-192°$ are displaced towards the red by a constant number of vibrations ($1/\lambda$ decreases by 14 units) as compared with those in the spectrum of the vapour. T. M. L.

51. *Limits of Uniformity in producing Optical Glass.* **J. W. Gifford.** (Roy. Soc., Proc. Ser. A. 87. pp. 189–198, Aug. 21, 1912.)—Determinations of the optical constants of 27 glass meltings by Schott, Parra-Mantois and Chance are analysed according to the procedure described in previous papers [Abstract No. 477 (1909)]. Three blocks were chosen at hazard from each melting and cut into approximately equilateral prisms, the surfaces being optically polished on all three sides. The mean refractive index for $\lambda 5270$ (E) was determined, the results being reduced to 15° C. All the values obtained are tabulated, from which it is shown that the heavy barium crown glasses are those which show the greatest variation in homogeneity in the same melting. C. P. B.

52. *Diffraction Grating Method for Determination of Refractive Indices of Liquids.* **F. A. Osborn** and **H. H. Lester.** (Phys. Rev. 35. pp. 210–216, Sept., 1912.)—A new method is described for measuring refractive indices, based on the determination of the ratio of the wave-lengths in air and in the liquid, employing a Rowland plane grating of approximately 15,000 lines to the inch, and an Abbe spectrometer. The grating, which is completely immersed in the liquid contained in a double-walled metal tank, and mounted on the fixed circle of the spectrometer, receives the light from the objective and returns the diffracted light along the same path as the incident light. The temperature is controlled by a heating coil wound on the outside of the tank, the whole being wrapped with several layers of asbestos. Since $m\lambda = 2d \sin \theta$, the refractive index is determined, if $d$ is constant, from the equation $\mu = \lambda_a/\lambda_w = \sin \theta_a/\sin \theta_w$, the subscripts referring to the air and liquid values respectively. Allowing for the change in temperature of the grating in the air and in the liquid, $\mu = (\sin \theta_a/\sin \theta_w)\ [1 + \alpha\,(t_1 - t_2)]$ approximately, where $t_1$ and $t_2$ are the respective differences in temperature between air and liquid readings, and that at which $d_0$ was determined, and $\alpha$ is the coefficient of expansion of the grating. The refractive index of water for the lines of Na, H, and Hg has been determined by the method, the results agreeing closely with those obtained by other investigators. W. H. Si.

53. *Influence of Temperature and Time on the Double Refraction of Strained Glass.* **E. Zschimmer.** (Archiv f. d. Physikal. Chem. d. Glases u. d. Keram. Massen, 1. Nos. 5 and 9, 1912. Zeitschr. Instrumentenk. 32. pp. 303–304, Sept., 1912.)—After a short summary of the observations made by Kerr and other investigators it is noted that hitherto the influence of temperature and the constitution of glass on the production of non-uniform double refraction by cooling, as well as the influence of temperature and time on the disappearance of stress and double refraction have been but little examined in a systematic way. Zschimmer has now made exact researches on 1-cm. cubes cut out of Jena glass and has especially sought to solve the following questions:—(1) For a given specimen of glass it must be ascertained how great is the value of the mean double refraction which is caused at various temperatures if the cube free from stress is suddenly brought from the region at $t°$ into a space at 20°, where it cools uniformly. (2) The thus ascertained curve of double refraction as function of the exciting and straining temperature $t$ should for various glasses be

determined, and thereby it should be found what influence the chemical constitution of the glass has upon the course of the stress curve. (3) From one kind of glass several cubes are brought to a chosen value of the double refraction, and thus the times measured which are necessary to bring to a minimum the existing double refractions at various temperatures. (4) The curves of release of tension are determined for various kinds of glass in order to find the influence of constitution. In the present paper some provisional results are given and further experiments are being carried out. The method of heating is by the electric current, the oven being a porcelain tube 2 cm. wide. Boric acid crown glass (with 8·5 % $B_2O_3$) and ordinary flint glass (48·8 % PbO) from Schott's have been tested. The crown glass was decidedly more resistant against permanent deformation than the flint glass; the latter is much more plastic than the former. Crown glass required a much longer period for release from strain than the flint glass, the temperatures being the same. At 415° the time of recovery for flint glass was 4 hours, for crown glass 4 days. J. J. S.

**54.** *Electric Double Refraction in Artificial Clouds.* **P. Zeeman** and **C. M. Hoogenboom.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 178–184, Sept. 8, 1912. Phys. Zeitschr. 13. pp. 918–920, Oct. 1, 1912.) —This is the third part of an account of investigations on sal-ammoniac vapour. The results obtained might be explained by supposing the existence of two varieties of sal-ammoniac crystals, and this dimorphism is a well-known fact. The phenomena previously described [see Abstracts Nos. 804, 662 (1912)] can be obtained with sublimated sal-ammoniac, so that the two modifications of the substance appear to exist after sublimation. The transition of one modification into the other may be accompanied by a change of the sign of the electric double refraction. Other methods were used for obtaining sal-ammoniac fogs: (1) A current of air was passed successively through bottles with a $NH_3$ solution and with a HCl solution. The tubes did not reach below the surfaces of the solutions. (2) Dried air was passed over heated, previously sublimated sal-ammoniac, and then introduced into the basin with exterior condenser plates. The air current and the heating of the sal-ammoniac being well regulated the putting on of the electric field caused a downward displacement of the band accompanied by a rotation of the plane of polarisation. After stoppage of the air current the band after a time exhibited the upward displacement. In some experiments the downward displacement could not be observed, and only a rotation was seen. This occurred especially with fogs of initially great density so that the field of view became dark. After partial precipitation of the fog the putting on of the field caused an upward displacement of the dark band. The results clearly point to the existence of two modifications of sal-ammoniac, the one first originated exhibiting a positive, the second a negative electric double refraction. Experiments show that the observed change of sign of the electric double refraction cannot be explained by a change of orientation of the particles constituting the fog. J. J. S.

**55.** *Sharp Interference Bands with Wedge-shaped Plates.* **E. Gehrcke** and **L. Janicki.** (Ann. d. Physik, 39. 2. pp. 481–488, Sept. 24, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Describes experiments with wedge-shaped plates, which show that such plates will give very sharp interference bands, the curve for the intensity distribution having sharp maxima. Light incident on such wedge-shaped plates in a plane perpendicular to the line of intersection of the two faces of the wedge, gives rise to a diverging or a converging beam according to whether it has a component away from or towards the apex of the wedge. The plane perpendicular to the line of intersection of the faces of the wedge is called the principal plane. For a given angle of incidence in the principal plane, the place where the emergent rays, whether diverging or converging, cut, is the farther from the plate, the smaller the angle of the wedge is. The diverging system will give rise to a system of virtual interference bands located behind the plate, the converging system giving real bands in front of the plate. These facts have been established, using partially silvered wedge-shaped plates of glass. Light from a mercury lamp (L) was condensed by a long-focus lens on to the wedge (W), a screen (S) receiving the transmitted light. Using the Hg 5460 line and a wedge of angle 0° 1′ 87″ and average thickness 1·88 mm., the distances being LW about 140 cm., WS about 20 cm., an exceedingly sharp set of interference bands was obtained. Photographs are reproduced of this system and of that obtained with the total light from the mercury lamp; the latter system is also well defined. If the light is not incident in the principal plane the bands are no longer sharp, but merge into one another, the bands being less sharp the farther one goes from the principal plane, but these bands always remain parallel to the edge of the wedge. Besides these there are other diffuse bands inclined to the edge of the wedge. Plates with non-plane surfaces, when partially silvered on both sides, will give sharp bands. Using a weak convex lens (0·25 dioptrie) with a plane glass plate, the surfaces in contact being silvered, the plano-concave air film gave sharp interference rings. Interference points were obtained and photographed by crossing a plane parallel glass plate 5·08 mm. thick and 20 cm. long (in a Lummer-Gehrcke interference spectroscope) with the 1·88 mm. wedge. The wedge was in this case about 10 cm. from the slit of the interference spectroscope so that the lens between the plate and slit was unnecessary. A fine adjustment for the wedge mounting was necessary to give the sharpest definition. In all cases the plates used were silvered by kathodic deposition, this giving the best results [see Abstract No. 759 (1911)]. Other experiments show that with the Lummer-Gehrcke arrangement it is more important to have the surfaces of the glass plate accurately plane than to have them absolutely parallel, since a wedge angle of only a few seconds simply has the effect of shifting the position of the plane of the interference bands. With two crossed wedges, a set of interference points is obtained, but the arrangement gives feeble illumination. The distance (D) of the interference plane from the wedge with varying angles of incidence ($\alpha$) in the principal plane was investigated for two wedges. It is seen from the curves obtained that Feussner's formula $D = [\sin\alpha \,.\, \cos^2\alpha / (n^2 - \sin^2\alpha)] \,.\, d/\omega$ (where $d$ is the thickness of the wedge, $\omega$ the wedge angle, and $n$ the refractive index of the material) which holds for two rays in the principal plane, with sinusoidal intensity distribution, also holds for a large number of interfering rays. For the same two plates, for which $d = 1{\cdot}77$ mm., $\omega = 0^\circ\ 2'\ 46''$; $d' = 1{\cdot}88$ mm., $\omega' = 0^\circ\ 1'\ 87''$ respectively, the relation between the band width ($s$) and the angle of incidence ($\alpha$) was investigated. The results agree well with Feussner's formula $s = [\lambda/2\omega] \cos\alpha / \sqrt{(n^2 - \sin^2\alpha)}$. Hence it appears that the position and the distance apart of the *sharp* interference bands due to many interfering rays, coincide with those for only two interfering rays with *sinusoidal* intensity distribution within the limits of experimental errors.

A. W.

56. *Emission Theories of Light.* **R. C. Tolman.** (Phys. Rev. 35. pp. 136–143, Aug., 1912.)—The Einstein theory of relativity assumes that the velocity of light is independent of the relative motion of the source of light and the observer. An alternative postulate has been suggested—that the velocity of light and the velocity of the source are additive. Theories based on such a postulate may be called emission theories. It may be assumed that on reflection the excited portion of a reflecting mirror acts as a new source of light, and that reflected light has the same velocity with respect to the mirror as has the original light with respect to the source. The possibility of this assumption was formerly suggested by the author, but apparently disproved by an experiment on the velocity of light from the approaching and receding limbs of the sun. In the present paper further evidence is given disproving the possibility of the assumption. According to an emission theory suggested by O. M. Stewart light reflected from a mirror acquires a component of velocity equal to the velocity of the mirror image of the original source. The author brings forward evidence to disprove the possibility of such a principle. A very complete emission theory of electromagnetism has been presented by Ritz, which has perhaps not received the critical attention that it deserves. According to this theory light retains throughout its whole path the component of velocity which it obtained from its original moving source, and after reflection light spreads out in spherical form around a centre which moves with the same velocity as the original source. Now the Michelson-Morley experiment was devised for detecting the motion of the earth through the ether, and hence if this experiment should be repeated, using light from the sun instead of from a terrestrial source, a positive effect might be expected if the Ritz theory were true. But if the Einstein theory were correct no effect would be obtained. A definite experimental decision between the relativity theories of Ritz and Einstein is of great importance.

J. J. S.

57. *Method for Measuring Speed of Light.* **C. Féry.** (Comptes Rendus, 155. pp. 823–824, Oct. 28, 1912.)—To avoid the difficulty of evaluating the angular velocity of the ordinary rotating mirror in the classic determination of the speed of light, the author suggests the substitution of a mirror carried on the end of one prong of a tuning-fork. Light from a source at one side is directed on to a screen by a plane plate at an angle of 45°. Through a slit in the screen light passes to the mirror on the fork, back through the slit to a distant mirror, and returns. Then, when the fork is set in vibration, the original beam gives two displaced images AA′ of the slit on the screen, due to the full motion of the prong. But two other images $aa'$ at a less distance apart are also obtained, and these are due to the slightly displaced positions of the prong when the light has returned from the distant mirror. Thus, if the time occupied by this double journey is $t$, and the period of the fork T, we have $\sin 2\pi t/\mathrm{T} = aa'/\mathrm{AA}'$. Thus, for a double distance of 30 km. and $\mathrm{T} = 0{\cdot}002$ of a second, $t = 0{\cdot}0001$, $aa'/\mathrm{AA}' = \sin 18^\circ = 0{\cdot}31$. So, if AA′ were 20 mm., $aa'$ would be of the order 6 mm. These two pairs of images could be photographed simultaneously, and so a considerable accuracy obtained.

E. H. B.

58. *Extinction of Light by an Illuminated Retina.* **W. Abney.** (Roy. Soc., Proc. Ser. A. 87. pp. 147–151, Aug. 13, 1912.)—An apparatus is described which enables the eye to observe a white disc, illuminated by white light, on which a sharp black shadow from a small opaque object is cast. The disc has

a hole in it through which a plate illuminated by light from any desired region of the spectrum can be seen. The experiment consists in varying the intensity of the coloured light until the brightness of the coloured patch disappears and it matches the dark shadow. The white illumination can also be varied. Curves are reproduced showing how this extinction point varies throughout the spectrum for different values of the white illumination. It is interesting to observe that the point of minimum extinguishing illumination travels towards the red with the rising white illumination. J. S. D.

59. *Natural and Magnetic Rotatory Dispersion.* **T. M. Lowry.** (Roy. Soc., Phil. Trans. 212. pp. 261–297, Oct. 28, 1912.)—This paper describes :—(1) A new test for the optical purity of quartz. (2) An accurate determination of the rotatory dispersive power of quartz for 24 wave-lengths in the visible spectrum. (3) Experiments to test the validity of Wiedemann's law. The author has found that the law holds good for quartz but not for optically-active liquids. J. M.

60. *Arc Spectrum of Iron.* **F. Goos.** (Zeitschr. wiss. Phot. 11. pp. 305–316, Sept., 1912.)—In a previous paper [Abstract No. 866 (1912)] the wave-lengths of lines in the arc spectrum of iron between λ4282 and λ5324 have been given on the international system. The present paper continues the table for the lines from λ5328 to λ6495. Thirty-three plates have been employed for the measurements, ample overlap being allowed. Comparisons are given with the values determined by Kayser, and also a series of special comparisons of wave-lengths obtained by different methods, using plane grating, concave grating, interferometer, etc., and with the light taken from a definite portion of the arc. C. P. B.

61. *Spectrum of Iron Arc with Alternating Current.* **M. Hamy.** (Comptes Rendus, 155. pp. 631–635, Oct. 7, 1912.)—In studying star spectra it is necessary to be able to produce a comparison spectrum which shall be determined exactly by the conditions of production. The condensed spark between iron electrodes, which has hitherto usually been employed, seldom yields, at two different times, two spectrograms exactly alike, even though all possible precautions are taken to secure the same conditions. In the present paper an alternating-current arc is described which gives very consistent results, is very easy to put in and out of action, and gives a large bright flame which affects photographic plates much more quickly than the condensed spark. At the end of the horizontal axle of an electric motor is fixed an iron rod (T), 6 mm. diam. and 100 mm. long, the rod being insulated from the axle, and at right angles to it. When the motor turns, the rod T becomes periodically vertical ; it touches then the end of a second rod T′, sensibly horizontal, and, in passing, makes this rod turn slightly about an axis A, which, in the author's arrangement, is about 100 mm. from the end of T′ where contact takes place between the rods. A suitable counterpoise causes the rod T′ to exert a constant pressure on the rod T at each contact. A stop can be adjusted so as to regulate the amount of depression of the end of T′ at each contact. Experience shows that the pressure between T′ and T should be very small, and that the depression of T′ should not be more than about 0·1 mm. When the two bars are connected to the ends of a sector, through a suitable resistance, sparks are produced at each contact break, and these constitute the luminous comparison source. A monophase induction motor was used of 0·1 h.p., and its speed on no-load (as was the case in the arrangement used) was very con-

stant. The time for the rotor to make a complete turn is a little less than the period of the alternating current actuating the motor. Also the phase of the current is not always the same each time the bars T and T′ come in contact. The appearance of the light ought thus to vary with the time; this was found to be the case. When the apparatus is working, flames start between the ends of the bars, develop, reach a maximum, diminish and disappear periodically. About 40 flames thus appear and disappear per minute. At a fixed voltage experience shows that the above arrangement gives remarkably constant results; practically identical spectrograms are obtained if the times of exposure are adjusted so as to obtain the same number of flames. If the voltage varies from that used (110 volts) to a neighbouring value V, Millochau has found that the time necessary to give a good photograph must be increased proportionately to the difference (110 — V). It is shown also how the apparatus may be used in the determination of radial velocities by Hartmann's method. A. W.

62. *Series Lines in Mercury Arc Spectrum.* **J. C. McLennan.** (Roy. Soc., Proc. Ser. A. 87. pp. 256–268, Sept. 19, 1912.)—This paper constitutes the first of a series of studies on the distribution of series lines in the arc spectrum of mercury, as well as on the constitution of some of these lines, and on their resolution by magnetic fields. The best source of light was found to be a commercial Cooper Hewitt glass lamp with a side tube attached, which was closed by a thin plate of crystalline quartz. This gave the best-defined and the greatest number of spectral lines. Photographs were obtained showing well-defined lines ranging from $\lambda = 2150$ to $\lambda = 7000$. In the triplet series of lines the following members have been identified:—(1) Principal series: 1st group to $m = 18$, 2nd group to $m = 10$. (2) First subordinate series: 1st group to $m = 20$, 2nd group to $m = 17$, 3rd group to $m = 16$. (3) Second subordinate series: 1st group to $m = 20{\cdot}5$, 2nd group to $m = 17{\cdot}5$, 3rd group to $m = 14{\cdot}5$. In the series of single lines the principal series has been identified to $m = 9$, the first subordinate to $m = 16$, and the second subordinate to $m = 12{\cdot}5$. Illustrations are given of the "combination series" lines, calculated according to the scheme proposed by Ritz from elements of the triplet series and single-line series formulæ [see Abstract No. 1619 (1908)]. Diagrams are given of the positions of the lines in the different series, also photographs of the spectrum. A. W.

63. *Absorption Spectra of Aqueous Solutions of Neodymium and Praseodymium as Measured by Means of the Radio-micrometer.* **H. C. Jones** and **J. S. Guy.** (Chem. News, 106. pp. 212–214, Nov. 1, and pp. 225–228, Nov. 8, 1912.)—A sensitive form of radio-micrometer is described in the form of a delicate moving-coil galvanometer, the coil of which consists of a single loop of thin copper wire with a blackened thermo-couple at one end. The elements forming the couple consist of alloys, one of which contains 90% Sn and 10% Bi, and the other 97% Sn and 3% Sb. When the coil, which with the couple and the attached mirror together weighs only 20 mgm., is suspended between the poles of a strong magnet, a very sensitive radiometer is obtained, which has been employed in the investigation of the absorption spectra of aqueous solutions of neodymium salts between $\lambda = 4000$ and $\lambda = 20{,}000$. From the radiometer readings, transmission curves have been plotted for the chloride, bromide, nitrate, sulphate, and acetate. According to these curves, the solutions in question exhibit sharply-defined absorption

maxima, and three of these, at λ = 7800, 7860, and 8605, have not been previously indicated in the experiments according to the photographic method. With regard to the influence of concentration on the absorption it is found that the bands are somewhat broader in the more concentrated solutions, but that the intensity of the bands increases with the dilution. This is interpreted in terms of the author's (Jones's) resonance theory. With praseodymium chloride and nitrate bands were located down in the infra-red as far as 2 μ. T. S. P.

64. *Ultra-red Emission Spectra.* **H. Lehmann.** (Ann. d. Physik, 39. 1. pp. 53–79, Sept. 5, 1912.)—Deals first with a source of error introduced into the results of wave-lengths obtained by the method of coincidence of different orders in grating spectra. Ritz showed [Abstract No. 2596 (1904)] that Lehmann's earlier measurements of ultra-red lines were in error by about 3 Å. The author now shows that the errors were not due, as suggested by Ritz and by Hermann, to a certain error of the camera objective, but to the fact that the law for limiting rays is not fulfilled, as was first shown by Abbe. A method of avoiding the difficulty is suggested. Using the phosphoro-photographic method and a similar spectrographic arrangement to that used by Bergmann [Abstract No. 915 (1908)], with lens specially corrected for ultra-red rays, measurements were made on about 20 metals. Wave-length tables are given extending to about λ15000 and photographs are reproduced. A. W.

65. *Structure of Mercury Line,* 5461 Å. **L. Janicki.** (Ann. d. Physik, 39. 2. pp. 439–448, Sept. 24, 1912. Communication from the Physikal-Techn. Reichsanstalt.)—The author finds the line five-fold with seven satellites—thus twelve components in all. He uses two crossed interference systems in order to have a means of distinguishing true lines from ghosts. J. M.

66. *Electric and Magnetic Double Refraction.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 5. pp. 577–593, 1912.)—This paper consists of:—(1) A generalisation of the Langevin theory of electric and magnetic double refraction (æolotropic molecules swung into line by the magnetic field, this alignment being opposed by heat). (2) A mathematical statement of the author's point of view—that the Zeeman-effect and the Langevin-effect are both operative: in some cases one will predominate, in some cases the other. J. M.

67. *Theory of the Zeeman-effect in any Direction.* **K. Försterling.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 5. pp. 611–622, 1912.)—The author makes use of the analogy of an isotropic body in a magnetic field to a uniaxial, absorbing crystal, which rotates the plane of polarisation of the incident light. It follows from the theory that the damping of the motion of the electrons may be measured, even for those lines which have not yet been reversed. J. M.

68. *Zeeman-effect.* **C. Wali-Mohammad.** (Ann. d. Physik, 39. 1. pp. 225–250, Sept. 5, 1912. Extract of Dissertation, Göttingen.)—The author has examined the zinc, cadmium, thallium, and bismuth lines and their satellites in fields from 5000 gauss down to 3000 gauss (in the case of very fine lines) with an echelon interferometer. J. M.

69. *Solutions of Wave Equation.* **A. Wiegrefe.** (Ann. d. Physik, 39. 2. pp. 449–484, Sept. 24, 1912. Extract of Dissertation, Göttingen.)—Discusses mathematically the many-valued solutions of the wave equation $\Delta u + k^2u = 0$ and their application in diffraction theory. E. H. B.

70. *Anomalous Dispersion in Sodium Vapour.* **D. Roschdestwensky.** (Ann. d. Physik, 39. 2. pp. 307–345, Sept. 24, 1912.)—A more complete account of the work dealt with in Abstract No. 1594 (1910).

71. *Colour-blindness and the Trichromatic Theory of Colour Vision.* IV. *Incomplete Colour-blindness.* **W. Abney.** (Roy. Soc., Proc. Ser. A. 87. pp. 326–330, Oct. 2, 1912.)—Explains a very simple test which gives a quantitative measure of the sensations in incomplete colour-blindness. [See also Abstract No. 709 (1912).] L. H. W.

72. *Spark Spectrum of Palladium.* **P. E. Dhein.** (Zeitschr. wiss. Phot. 11. pp. 317–348, Oct., 1912.)—Describes photographic measurements of wavelengths of the spark lines of Pd, using the Rowland concave grating of the Physical Institute at Bonn. Tables are given of the lines from $\lambda$6784·622 to $\lambda$1971·699, the results being compared with those of Kayser, Exner and Haschek, and Morse and Lohse. Many new lines below $\lambda$2185 are given. A. W.

73. *False Dissymmetries in the Zeeman-effect.* **K. Körner.** (Phys. Zeitschr. 13. pp. 797–808, Sept. 1, 1912.)—This paper deals with dissymmetries in the separation of lines by the magnetic field, arising from small errors in the adjustment of apparatus, pressure variations in the source of light, and other effects. J. M.

74. *Dispersion and Absorption of Mercury and Tin for the Visible and Ultraviolet Spectrum.* **P. Erochin.** (Ann. d. Physik, 39. 1. pp. 213–224, Sept. 5, 1912.)—A continuation of the work of W. Meier and V. Freedericksz. [See Abstract No. 819 (1910).] J. M.

75. *Quantitative Determination of Radium Emanation.* **L. Flamm** and **H. Mache.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 227–246, Feb., 1912.)—The theoretical value of the saturation current, produced when emanation is distributed homogeneously between two parallel plates and the active deposit in equilibrium with the emanation is collected on the negatively charged plate only, has been investigated mathematically. The formulæ developed are tested and found in agreement with experiment. The saturation current for the $\alpha$-rays from RaEm alone was found to be $2{\cdot}67 \times 10^6$ e.s. units per curie, and that for emanation RaA and C $6{\cdot}02 \times 10^6$ e.s. units. E. M.

76. *Vienna Standard Radium Preparations.* **S. Meyer** and **V. F. Hess.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 603–631, April, 1912. Communication from the Inst. f. Radiumforschung.)—The standard preparations consist of the $RaCl_2$ prepared by Hönigschmidt in his determination of the atomic weight of Ra [Abstract No. 759 (1912)]. The present paper deals with (1) the heat evolution; (2) the ionisation due to the $\alpha$-rays from a very thin film of the substance; (3) the ionisation due to the $\gamma$-rays, and (4) the amount of emanation in equilibrium with the material. The heat evolution of 1 gm. radium element in equilibrium with its products (emanation, RaA,

B, and C) when all the α- and β-rays and 18% of the γ-rays were absorbed was found to be 182·28 gm. cals. per hour, or if all the γ-rays were absorbed 188 gm. cals. per hour. The calculated value based on the ordinary results for the initial velocities of expulsion of α-rays is very approximately the same as the experimental value. Different methods of determining the Ra-content of a preparation from its γ-ray ionisation were tested, and data are given for various dispositions, by means of which an ordinary preparation of radium can be standardised without the necessity of comparing it directly with a standardised preparation. The measurements of the current produced by 1 curie of RaEm in a cylindrical chamber without subsequent products gave the value $2{\cdot}7 \times 10^6$ e.s. units, which is in good agreement with the result of Flamm and Mache [see preceding Abstract]. From the thorium content of the residues from which the Ra was extracted, and the fact that ionium is separated out with Th, it was deduced that the period of average life of ionium cannot exceed about 200,000 years. E. M.

**77.** *Comparison of Ionisations within Closed Vessels due to Röntgen and Gamma Rays.* **A. S. Eve.** (Phil. Mag. **24.** pp. 482–486, Sept., 1912.)—If closed cylindrical vessels, made of various metals, equal in height and diameter and with walls about ½ mm. thick, are exposed to the action of Röntgen rays and of the γ-rays from RaC respectively, then the following results obtained give a comparison of the ionising effects of the two types of rays :—

IONISATIONS.

| Metal. | Atomic Weight. | Density. | Thickness. | X-Rays. | γ-Rays. |
|---|---|---|---|---|---|
| Lead | 207 | 11·3 | 2·1 mm. | 1·8 | 100 |
| Copper | 63·6 | 8·9 | 0·54 | 82 | 69 |
| Zinc | 65·4 | 7·1 | 0·44 | 111 | 69 |
| Iron | 55·9 | 7·8 | 0·55 | 100 | 68 |
| Aluminium | 27·1 | 2·6 | 0·64 | 126 | 58 |
| Cardboard | — | — | — | 125 | 49 |

The X-rays used came from a rather hard bulb, and their absorption coefficient in air was 0·0004 $\text{cm}^{-1}$. The results are at first sight very surprising, although they are not out of harmony with the view that the X- and γ-rays are similar in type. The explanation is based on the view that the X-rays ionise wholly by electrons projected with velocities of the same order as that of the kathode rays, and that the γ-rays also ionise by electrons projected with velocities of the same order as those of the β-rays from RaC. The corpuscles ejected by X-rays only traverse a distance of about 1 mm. in air, and originate chiefly in the air in the testing vessel. The decrease in ionisation with increasing density of material is due to increased absorption by the walls of the vessel. The electrons ejected by the γ-rays come chiefly from the walls of the vessel, and have an average path of about 2 m. Moreover, they are reflected to and fro by the walls of the vessel, in this way increasing the ionisation. The results for the variation of the ionisation with the vessels of different materials agree well with the results of Kovarik for multiple reflection of β-rays with the corresponding metals. [See Abstract No. 852 (1911).] E. M.

78. *International Radium Standard.* **Mme. P. Curie.** (Journ. de Physique, 2. Ser. 5. pp. 795–826, Oct., 1912.)—The paper contains an account of the method of comparing quantities of radium, particularly the γ-ray method. An ionisation chamber or γ-ray electroscope is recommended with lead walls at least 5 mm. thick. For correction, if the radium samples are not contained in the same vessels, $\mu$ for glass may be taken to be 0·1 cm.$^{-1}$, and for lead 0·5 cm.$^{-1}$. For glass vessels of ½ mm. thickness the absorption of the γ-rays is only about 0·5 %. Correction may be necessary in some cases for the absorption of the γ-rays by the material itself. It is necessary that the radium samples should have been sealed up at least a month previous to measurement so that the equilibrium amount of emanation may have been produced. The international radium standard is next described. This was prepared by Mme. Curie from the material used in 1907 for the determination of the atomic weight of Ra, the value found being 226·5. Part of this radium was purified from RaD, E, and F, and weighed in the form of anhydrous $RaCl_2$, the weight being 0·02199 gm. ($RaCl_2$). This was placed in a glass tube of wall thickness 0·27 mm. and diam. 0·9 mm., and sealed off in Oct., 1911, with a piece of thin Pt-wire also sealed into the tube. The standard was compared with that prepared by Honigschmidt of Vienna (0·03117 gm. $RaCl_2$), and the two were found to have γ-ray activities corresponding to the weights to within 0·2 %. The International Congress have therefore accepted Mme. Curie's radium preparation as standard to be placed in the Bureau international des Poids et Mesures. It is pointed out that as the radium was prepared from Joachimstal pitchblende, which contains little Th, no appreciable disturbance can arise from mesothorum, which is known to be always separated out chemically with Ra. E. M.

79. *Charge carried by α- and β-Rays.* **J. Danysz** and **W. Duane.** (Comptes Rendus, 155. pp. 500–503, Sept. 2, 1912.)—The experiments deal with the total charge carried by the α- and β-rays emitted from 1 curie RaEm in equilibrium with RaA, RaB, and RaC. As source a small bubble of emanation was used in a thin-walled spherical glass "α-ray bulb," the rest of which was filled with mercury. A definite beam of rays was taken and received by a Faraday cylinder connected to a quartz piézo-électrique. The apparatus was placed between the poles of an electromagnet. With no magnetic field the Faraday cylinder received charges due to α-, β-, and δ-rays. The latter were found to be cut off by a field of 60 gauss, the charge received being constant between 60 and 120 gauss and corresponding to the difference in the charges carried by the α- and β-rays. With increasing field up to 2500 gauss the β-rays were gradually cut off, and the positive charge received increased to a constant value from 2500 upwards to over 3000 gauss. This constant value was taken as a measure of the charge carried by the α-particles, and was found to be 90·8 e.s. units per curie, which is approximately 3 times the value 31·6 found by Rutherford and Geiger for RaC alone. The ratio of the charge carried by the β-rays to that of the α-rays was found to be 0·63, which, on the assumption that an α-particle carries a double positive charge, indicates 3·8 β-particles for the 3 α-particles (RaEm, A, and C). Corrections were necessary on account of a small fraction of very slow β-particles ($v<1{\cdot}8 \times 10^{10}$) which do not emerge from the bulb, and also for the reflection by the mercury. The authors conclude that there are at least 3, and perhaps 4, β-particles for the 3 α-particles. It is also concluded from the experiments that slow secondary rays of the nature of δ-rays are not excited in appreciable quantity by β-particles. E. M.

80. *Demonstration of Range of α-Particles.* **K. Przibram.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 221–226, Feb., 1912.)—The paper deals with a simple apparatus for showing that α-particles have a limited range in air. A uniform fog of ammonium chloride is produced in a shallow chamber with parallel electrodes. α-particles are fired in from one end and an electric field applied. This electric field removes the fog in the region where the α-particles have produced ionisation, and the clear part of the tube is sharply divided from the foggy part. The length of the clear part is the range of the α-particles under consideration. The apparatus works specially well with polonium, owing to the absence of β-radiation with this product. E. M.

81. *Variation of β-Radiation of Radium.* **F. v. Lerch.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 875–891, May, 1912.)—The author concludes from experiments that there is a radio-active product, designated RaX, between radium and radium emanation [see Abstract No. 80 (1911)]. A quantity of radium was subjected to various chemical and electrochemical operations, dissolved completely in acid, and the solution sealed up. The β-ray activity was then measured for several months. For the first 40 days the β-radiation increased to a practically constant value, due to the growth of RaEm, but over a period of several months subsequent to this it in some cases increased slightly and in others decreased, according to the various chemical operations previously undergone. These slow variations with time, amounting in some cases to over 10%, appear too large to be attributed to experimental error. The author suggests that the ratio of the radium to the new subsequent product RaX has been altered by the operations. When the ratio of RaX to Ra exceeds the equilibrium amount the β-radiation decays gradually after the equilibrium amount of emanation has been formed, and *vice versa*. E. M.

82. *β-Particles Reflected by Sheets of Matter of Different Thicknesses.* **W. Wilson.** (Roy. Soc., Proc. Ser. A. 87. pp. 100–108, Aug. 13, 1912.)—The author has investigated the nature of the β-rays reflected from various metal sheets when β-rays of UrX are incident on them. The UrX was obtained in a very pure form from 50 kg. of uranium nitrate. It is shown that the radiation can be split up into two parts: one with a very large coefficient of absorption, and the other with an absorption coefficient of the same order as that of the primary beam but decreasing with increasing thickness of the reflector. For very thick sheets the final absorption coefficients in Al of the more penetrating reflected radiation are found to be: Al, 33·7; Cu, 26·6; Pb, 20·2 cm.$^{-1}$. The coefficient of absorption of the easily absorbed part of the radiation reflected by Al is found to be 285 cm.$^{-1}$; and values of the same order are deduced for Cu and Pb. An expression is obtained for the variation of the amount of reflected radiation with thickness of reflector. E. M.

83. *Reflection of β-Rays by Thin Metal Plates.* **W. B. Huff.** (Phys. Rev. 35. pp. 194–202, Sept., 1912.)—The author used the β-rays from UrX and examined the quantity and absorption properties of the β-rays scattered so much as to emerge again on the incident side of various metal foils. It is shown that even the thinnest obtainable metal foils reflect a measurable amount of the incident β-radiation, the increase with thickness of foil being at first linear. With increasing thickness of reflector the reflected radiation was found to contain an increasing proportion of softer constituents, this being regarded as evidence of loss of speed due to passing through matter. E. M.

**84.** *Number of β-Particles Emitted in the Transformation of Radium,* **H. G. J. Moseley.** (Roy. Soc., Proc. Ser. A. 87. pp. 230–255, Sept. 19, 1912.)—The recent researches of v. Baeyer, Hahn and Meitner [Abstract No. 319 (1912)] have shown that the β-radiation from a substance can usually be resolved by a magnetic field into a number of distinct groups of approximately homogeneous rays. It has been shown by Danysz [Abstract No. 325 (1912)] that more than 28 such groups are present in the radiation from RaB and RaC. It is, therefore, of interest to know the number of β-particles emitted per disintegrating atom emitted by these products. This number was determined by two methods. In the first method the particles were collected in a brass box thick enough to stop them all, and their number was deduced from the negative charge gained by the box. In the second method measurement was made of the positive charge gained by the active material (the α-particles being absorbed) as the result of the loss of β-particles. The number of disintegrating atoms was deduced from the α-particle measurements of Rutherford and Geiger. The results show that each atom of RaB and of RaC emits, on disintegrating, probably one β-particle, although measurement gives in either case as the average number 1·10. Each atom of RaE appears to emit less than one β-particle. The absorption of the β-radiation from the active deposit was studied, measurements being made both of the number of β-particles penetrating the absorbing material and of the ionisation they produce. From these data the ionising power of a β-particle in air, and its variation with the absorption coefficient of the radiation have been calculated; the number of ions produced per cm. of path being found to vary from 82 when $\lambda = 15$ cm.$^{-1}$ of Al to about 160 when $\lambda = 100$ cm$^{-1}$. With the help of the data obtained by Geiger and Kovarik the numbers of β-particles emitted on disintegration by atoms of UrX, ThD, and AcD were estimated to be 1, 0·8, and 1·4 respectively. The author deduces on certain assumptions, that each atom of RaC emits, on disintegrating, two γ-rays. The experiments also show that surfaces penetrated by β-rays emit a secondary radiation very similar to δ-rays. E. M.

**85.** *Half-value of the Radio-active Deposit Collected in the Open Air.* **F. A. Harvey.** (Phys. Rev. 35. pp. 120–127, Aug., 1912.)—It is shown from theoretical considerations that the half-value of a mixture of the active deposits from radium and thorium emanations must vary between very wide limits (45 mins. to several hours) if the percentage of Th active deposit varies from 0 per cent. to 50–70 per cent. Moreover it is shown that when atmospheric conditions are favourable, *i.e.* steady barometer and only slight changes in the wind, very good agreement is obtained between theory and experiment for the mixture of active deposits collected on a negatively-charged wire exposed in the open air. J. J. S.

**86.** *Radio-activity of Hot Springs of Yosina, Idu (Japan).* **D. Isitani.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 18. pp. 275–279, July, 1912.)—The paper deals with experiments in continuation of those described in Abstracts Nos. 708, 1222 (1912). Two hot springs were investigated at temperature 47° C. The mean emanation-content was 78 × $10^{-12}$ curies per litre of water and 587 × $10^{-12}$ curies per litre of evolved gas (47° C.). E. M.

**87.** *Progress in Radio-activity Research,* 1908–1912. **O. Hahn.** (Zeitschr. Elektrochem. 18. pp. 764–787, Sept. 1, 1912.)—A useful general survey.

# HEAT.

88. *Measurements of Expansion with Abbe-Fizeau Dilatometer.* **W. Bein.** (Kaiserl. Normal-Eichungs Kommission, Wiss. Abhandl. No. 8. pp. 3–52, 1912. Deutsch. Phys. Gesell., Verh. 14. 24. pp. 1097–1114, Dec. 30, 1912. Extract.) —Describes an elaborate series of measurements of the expansion of quartz, certain steels, brass, bronze, and copper at temperatures ranging from about 16° C. to 100° C. The formulæ of Benoît and Scheel for the expansion of quartz are verified, a very large number of measurements giving close agreement with the mean formula $Q_t = Q_0(1 + 715{\cdot}25 \times 10^{-9}t + 0{\cdot}808 \times 10^{-9}t^2)$.

A. W.

89. *Specific Heats of Liquids at Constant Pressure.* **S. Lussana.** (N. Cimento, 4. Ser. 6. pp. 207–232, Sept., 1912.)—Continuing his investigation of the subject [Abstract No. 658 (1909)] the author has determined the specific heats at constant pressure of mercury, methyl alcohol, acetone, amyl alcohol, and ether at different temperatures and pressures. It is concluded that, in general, the specific heat at constant pressure diminishes with increase of pressure, the results obtained being rather lower than those calculated from the isobars, and the diminution being approximately proportional to the increase of pressure. With increase of temperature, the reduction in the value of $c_p$ with increase of pressure becomes less, in some cases changing into an increase; $c_p$ increases with increase of temperature in the case of mercury only. The coefficient of variation of the specific heat with pressure for different temperatures, according to the equation $(c_0 - c_p)/c_0 p = \gamma$, is given in the following table:—

| | Temperature. | $\gamma \times 10^8$. | | Temperature. | $\gamma \times 10^8$. |
|---|---|---|---|---|---|
| Mercury ......... | 63·4° | − 1890 | Acetone ... | 12·5° | − 14728 |
| Mercury ......... | 90·5 | − 2581 | Acetone ... | 42·3 | − 4665 |
| Amyl alcohol ... | 52·2 | − 5189 | Ether ...... | 26·1 | − 14093 |
| Amyl alcohol ... | 77·4 | + 7238 | Ether ...... | 6·7 | − 14763 |
| Methyl alcohol... | 11·9 | − 8331 | Ether ...... | 9·4 | − 14719 |
| Methyl alcohol... | 44·7 | + 32551 | Ether ...... | 46·6 | − 12908 |

A modification of the method of mixtures has been employed, and a full description of the apparatus, together with diagrams, is given. W. H. Sı.

90. *The Melting-point of Cupric Oxide.* **R. E. Slade** and **F. D. Farrow.** (Zeitschr. Elektrochem. 18. pp. 817–818, Sept. 15, 1912.)—L. Wöhler stated in 1906 [see Abstract No. 146 (1907)] that cupric oxide heated at atmospheric pressure in a strong current of oxygen (Pt crucible in electric furnace) melted at 1055° C., and that the cooling curve showed a bend at 1064°; he did not analyse the fused product. The authors repeated these experiments, also by the method of G. K. Burgess, and found that the melting-point of CuO varied between 1096° and 1150°, because decomposition took place; copper itself gave in hydrogen after Burgess' method the melting-point 1078° (instead of 1083°). The melting-point of CuO seems to lie above 1148°; for it does not melt at that temperature under an oxygen pressure of 2·5 atmos. but

begins to decompose then. It begins to liberate oxygen, however, at 1090° already when heated in an oxygen atmosphere at ordinary pressure; the liquid contains more than 50 per cent. of $Cu_2O$ and solidifies completely at 1064°, which is Wöhler's point. H. B.

**91.** *Realisation of the Thomson-van der Waals p-T-v-surface.* **J. Meyer.** (Zeitschr. Elektrochem. 18. pp. 709–710, Aug. 15, 1912. Paper read before the Deutsche Bunsen-Gesell., Heidelberg, May, 1912.)—The author has determined the temperatures to which different liquids can be heated under a pressure of $p = 0$ before vapour formation occurs, with the following results:—

| Sub tance. | $T'_{\text{found}}$. | $T'_{\text{calc.}}$. |
|---|---|---|
| Ethyl ether ................ | 273 + 115° | 273 + 123° |
| Methyl ethyl ether ...... | 273 + 58 | 273 + 64 |
| Isopropyl ethane .......... | 273 + 95 | 273 + 97 |
| Benzene .................... | 273 + 168 | 273 + 194 |
| Ethyl alcohol ............ | 273 + 155 | 273 + 155 |

Van der Waals has shown that the value of T′ is equal to (27/32)T″, where T″ is the critical temperature. The values in the third column of the table have been calculated from this relationship. The author holds that the above experimental material confirms the existence of a minimum for the Thomson-van der Waals surface. It may be mentioned that in the case of water the author found that the temperature could be raised to 220° without formation of vapour occurring, the water being under a pressure of $p = 0$. A. F.

**92.** *Researches on Specific Heats.* I. **J. N. Brönsted.** (Zeitschr. Elektrochem. 18. pp. 714–717, Aug. 15, 1912.)—The author has determined the specific heats of a number of substances, the values found being given in the following table:—

| Substance. | Specific Heat. | Atomic or Molecular Weight. | Atomic or Molecular Heat. |
|---|---|---|---|
| Tin (white) ........................ | 0·05382 | 119·06 | 6·408 |
| Tin (grey) .......................... | 0·04962 | 119·06 | 5·908 |
| Potassium hydrogen tartrate | 0·2314 | 118·01 | 43·50 |
| Potassium hydrogen racemate | 0·2348 | 118·01 | 44·14 |
| Aragonite ........................ | 0·1899 | 100·12 | 19·01 |
| Iceland spar........................ | 0·1887 | 100·12 | 18·89 |
| Thallous picrate (yellow) ...... | 0·134 | 432·1 | 57·9 |
| Thallous picrate (red) ......... | 0·137 | 432·1 | 59·2 |
| Ammonium chloride............ | 0·3594 | 53·50 | 19·23 |
| Lead chloride ...................... | 0·06565 | 278·0 | 18·25 |
| Ammonium lead chloride...... | 0·0866 | 609·5 | 52·78 |
| Silver chloride .................. | 0·08775 | 143·35 | 12·58 |
| Mercuric chloride ............... | 0·05019 | 235·76 | 11·83 |
| Silver.................................. | 0·05535 | 107·89 | 5·972 |
| Mercury ............................ | 0·03325 | 200·3 | 6·660 |

The results obtained by the author are in harmony with the van't Hoff-Thomson rule that when a transition point is present the form stable at higher temperatures has the greater specific heat; but in the case of the two forms of tin the values are not in harmony with the Richarz rule that the substance with the higher specific heat has the smaller specific gravity. This is contrary to a result found by Wigand [Abstract No. 1031 (1907)]. From the results obtained in the case of the last seven substances in the above table it is possible to calculate the temperature coefficient of the heats of reaction in the two cases—

$$NH_4Cl_{\text{cryst.}} + 2PbCl_{2\,\text{cryst.}} \longrightarrow NH_4Cl_1 2PbCl_{2\,\text{cryst.}}.$$
$$Ag_{\text{cryst.}} + HgCl_{\text{cryst.}} \longrightarrow AgCl_{\text{cryst.}} + Hg_{\text{liq.}}$$

For the former reaction we obtain $A = 2780$, $dA/dT = +8{\cdot}3$; $U = +350$, $dU/dT = +3{\cdot}0$. For the latter reaction, $A = +1050$, $dA/dT = +8{\cdot}0$; $U = -1300$, $dU/dT = -1{\cdot}4$. A. F.

**93.** *The Nitrogen Thermometer Scale from* 300° *to* 630°. **A. L. Day** and **R. B. Sosman.** (Amer. Journ. Sci. 33. pp. 517–533, June, 1912. Ann. d. Physik, 38. 4. pp. 849–869, July 12, 1912.)—In the recent investigation of the fundamental high-temperature scale with the gas thermometer attention was chiefly directed to the temperature region above 1000°. Determinations of the lower temperatures have been made in the Reichsanstalt [see Abstracts Nos. 2003 (1900), 1979 (1903), 400 (1910)]. The authors have repeated their measurements with more elaborate precautions to secure a uniform temperature about the bulb—the one factor in the measurements about which some uncertainty remained. The new gas-thermometer temperatures are collected in the following table, expressed in terms of N expanding at constant volume from an initial pressure of 76 cm., and in terms of the thermodynamic scale. These values replace the corresponding temperatures published in the authors' previous papers:—

| Point. | Temperature. | | Notes. |
|---|---|---|---|
| | Const. Vol. $p_0 = 1$ atmo. | Thermodynamic. | |
| Benzophenone (Kahlbaum) boiling-point at 76 cm. | 305·85 | 305·9 | Transferred by platin-rhodium and copper-constantan thermo-elements. |
| Cadmium, melting-point ... | 320·8 | 320·9 | Interpolated. |
| Zinc, melting-point ......... | 419·3 | 419·4 | Transferred by thermo-elements. |
| Sulphur, boiling-point at 76 cm. | 444·40 | 444·55 | Direct. |
| Antimony (Kahlbaum), melting-point | 629·8 | 630·0 | Transferred by thermo-elements. |
| Aluminium, melting-point | 658·5 | 658·7 | Interpolated. |

A comparative table is added showing in terms of the same (thermodynamic) scale a comparison of the results with those obtained by Holborn and Henning in the latest work published from the Reichsanstalt.

COMPARATIVE TABLE.—THERMODYNAMIC SCALE.

| Point. | Holborn and Henning, 1911. | Day and Sosman, 1912. |
|---|---|---|
| Benzophenone ........................ | 305·9 | 305·9 |
| Cadmium ........................ | 320·9 | 320·9 |
| Zinc ........................ | 419·4 | 419·5 |
| Sulphur ........................ | $444{\cdot}5_1$ | $444{\cdot}5_5$ |
|  | Holborn and Day. |  |
| Antimony ........................ | 630·6 | 630·0 |

J. J. S.

94. *Spheroidal State.* **C. W. Batdorf.** (Phys. Rev. 35. pp. 217–226, Sept., 1912.)—Measured by means of a Pt and Pt-Rh thermo-couple, the temperature of water in the spheroidal state is found to vary between 97·5° and 91·76° C., gradually falling as the globule of water becomes smaller from evaporation. Occasionally the temperature remains fairly constant for a minute or more, with an approximate equilibrium temperature of 96·18°. The temperature of the plate, at which, as it cools, the spheroidal drop touches it, varies with the nature of the plate, depending on its conductivity. It also varies with the size of the drop, in the case of an iron plate being 260° for a drop of 2 gm. and 230° for a drop of 0·5 gm. The star forms and other figures produced by water, mercury, liquid air, ether, etc., in the spheroidal state have been fully studied, and photographs of many of these are reproduced.
W. H. Si.

95. *The Melting of Ice.* **E. E. Somermeier.** (Phys. Rev. 35. pp. 128–135, Aug., 1912.)—It was found that dry ice sticks and crystals inside a test-tube which is immersed in a mixture of ice and water, will melt at the same time that other ice crystals are freezing out of the mixture surrounding the tube, the crystals inside the tube and the mixture surrounding it both being at atmospheric pressure and the temperature of the room being 0° C. or below. The author can offer no satisfactory explanation of the results. Experimental efforts to explain them are negative. Various suggested possible explanations lack experimental proof. J. J. S.

96. *The True Second Law of Thermodynamics.* **J. T. Wainwright.** (Engineer, 113. p. 658, June 21, and 114. p. 90, July 26, 1912.)

97. *Kirchhoff's Law.* **F. Richarz.** (Zeitschr. wiss. Phot. 11. pp. 254–260, Aug., 1912.)—A theoretical discussion and demonstration of Kirchhoff's law. A. W.

98. *Boltzmann Proof of Second Law.* **P. Hertz.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 566–576, 1912.)—Statistical treatment for the second law of thermodynamics. [See Abstracts Nos. 815 (1911) and 521 (1912).] E. H. B.

99. *Constant in Stefan-Boltzmann's Law.* **S. Valentiner.** (Ann. d. Physik, 39. 2. pp. 489–492, Sept. 24, 1912.)—Comments on previous work with a bibliography. [See Abstracts Nos. 1229, 1230, and 1231 (1912).] E. H. B.

# SOUND.

**100.** *Duration of Sound of Alloys as a Function of Temperature.* **F. Robin.** (Rev. de Métallurgie, 9. pp. 618–687, Aug., 1912.)—The duration of the sounds of suspended bars of metal varies with temperature, and the nature of this variation has here been investigated and shown as graphs in sixteen figures dealing with pure metals, bronzes, brasses, and German silvers. The pure metals are of feeble sonority, whereas certain alloys show a marked improvement due to the introduction of a very small quantity of some constituent. Many of the curves show a decrease of duration of sound with rise of temperature up to about 300° C., and then a sudden increase to about 350° with a second falling-off for higher temperatures. E. H. B.

**101.** *Time Needed for Perception of Pitch.* **G. Leimbach.** (Ann. d. Physik, 39. 1. pp. 251–254, Sept. 5, 1912.)—Puts forward a proposed method, by means of telephones, contacts, and a pendulum, for the determination of the time needed for the appreciation of the pitch of a musical sound. The minimum time found by O. Abraham and L. J. Brühl in 1898 was 0·00068 sec for the four-times accented *g*, being two of its complete vibrations. E. H. B.

**102.** *Sound Vibration Curves.* **D. C. Miller.** (Engineering, 94. p. 550, Oct. 12, 1912. Paper read before the British Assoc. at Dundee.)—For photographic registration of sound vibration curves a horn is used to take up the vibrations, a diaphragm of glass, 0·08 mm. in thickness, and a fine thread of Pt (or quartz) attached to the membrane. This thread was kept stretched by a load of 5 gm., and led to a steel spindle, 0·01 mm. diam. and a mirror—these two together did not exceed 2 mgm. in mass. The apparatus responded to 12,000 complete periods per sec. The room in which the experiments were made was padded with 1¼ in. of felt. The vibration photographs of a tuning-fork (256) were almost perfect sine curves, a stopped organ-pipe gave a clear curve without any overtone, an open pipe gave one overtone. The vibrating string of a violin showed the ripples or steps of the overtones described by Helmholtz, and vowels and words spoken produced very peculiar curves. The violin gave eleven overtones, the clarionet hundreds of overtones. When some of these curves were analysed with Henrici's analyser for Fourier series, and the curves then reproduced by a synthetiser, it was found that the horn exaggerated certain waves to four times their amplitude and reduced others. E. H. B.

**103.** *Reed Pipes with Conical Portions.* **E. Hoppe.** (Ann. d. Physik, 39. 3. pp. 677–692, Oct. 15, 1912.)—Recounts a series of experiments on reed organ-pipes with a conical portion at the end. Four pipes were dealt with, three having brass reeds and one a steel reed. The experiments lead to the practical conclusion that the pitch of the pipe may be controlled not only by the tuning wire which shortens the reed, but also by the *shading* (or contraction) of the opening. Further, the conical portion in general plays only the part of the funnel in a megaphone. So soon, however, as the length of the conical part is sufficient to make its own tone correspond to any overtone of the fundamental, then it both increases the intensity and affects the quality of the pipe. E. H. B.

# ELECTRICITY AND MAGNETISM.

## THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

104. *Drop Method for Electronic Charge.* **A. C. Lunn.** (Phys. Rev. 35. pp. 227–230, Sept., 1912.)—Points out a correction theoretically needed in the above method for determining the elementary charge. But the numerical calculation shows that in Millikan's determination this correction would be of the order only one part in ten thousand. E. H. B.

105. *Electrified Particle in Magnetic Field.* **R. Birkeland.** (Archives des Sciences, 34. pp. 105–119, Aug., 1912.)—A defence of a previous paper by the author against an attack on it by C. Störmer. [See Abstract No. 896 (1912).] E. H. B.

106. *Contact Difference of Potential.* **A. Anderson and H. N. Morrison.** (Phil. Mag. 24. pp. 302–307, Aug., 1912.)—The contact p.d. of two metals depends on the state of the surface of the metals. The effect of making the surface of a metal bright and clean is to render it more electro-positive to other metals, and the magnitude of the effect is different for different metals. It was found that the contact p.d. in volts relative to a plate of uncleaned copper was in the case of freshly cleaned zinc 0·826 volt, and for uncleaned zinc 0·466 volt. Similarly the number for freshly cleaned Cu towards uncleaned Cu was 0·060 volt. The effect is a surface effect and experiments were made to test the action of ultra-violet light on the contact p.d. when copper and zinc were examined, the latter being exposed to ultra-violet light. It was found that with a powerful source of ultra-violet light there is a decided electro-negative increase which disappears slowly when the source is removed. The explanation on the electron theory of the results obtained is discussed in the paper. J. J. S.

107. *Residual Charge of Leyden Jar.* **G. Brentano.** (Phys. Zeitschr. 13. pp. 855–858, Sept. 15, 1912.)—A Leyden jar is charged with electricity of one sign, then discharged and afterwards charged with electricity of the opposite sign. It is then discharged, and its electrical behaviour observed by means of an electrometer. It is found that the first residual charge reappears after the second, even though the jar may have been charged in the second case to a higher potential than at first. Mechanical vibration has no effect on the reproduction of the residual charges. T. P. B.

108. *Behaviour of Ionised Liquid Dielectrics during the Passage of Electric Currents.* **H. J. van der Bijl.** (Ann. d. Physik, 39. 1. pp. 170–212, Sept. 5, 1912. Abstract of Dissertation, Leipzig.)—The theory of electrical conductivity in dense gases can be applied to ionised liquid dielectrics. In particular the recombination of ions in liquid dielectrics proceeds according to Thomson's formula $dn/dt = -an^2$. The coefficient of recombination of ions in hexane, carbon tetrachloride and carbon disulphide were determined independently of the influence of diffusion. Langevin's formula was verified experimentally and used to determine the sums of the mobilities of the positive and negative ions. Their diffusion-constants in hexane were determined by a new direct

method. The charges of the ions in hexane were determined and were found to be the same for positive and negative ions and in each case to be equal to the charge of the hydrogen atom in electrolysis. T. M. L.

**109.** *Diurnal Variations of the Electric Waves occurring in Nature and Propagation of Electric Waves round the Bend of the Earth.* **W. H. Eccles.** (Roy. Soc., Proc. Ser. A. 87. pp. 79–99, Aug. 13, 1912.)—Natural electric waves are probably the result of discharges between masses of electrified air, or between such masses and the earth. Until recently it was not known whether the discharges at any station were taking place at distances of hundreds of miles or thousands of miles, but it is now certain that, for England, the distances are of the order of thousands of miles. The number of natural wave-trains or "strays" received varies from hour to hour, and in England the variations are most pronounced during the summer months, principally on account of the frequency of local lightning storms during these months. In the winter, the number and intensity of the strays are relatively regular. The author gives typical 24-hour records, made by the aid of a telephone. The records are made by pencil-marks on paper ruled in convenient units of time so that the height of the mark represents the intensity, and the shape of the mark the duration and character, of the sound. These records can be made to yield approximately accurate quantitative results by plotting rough estimates of the time integral of the intensity of the strays. One method of doing this is to count the number of marks in each 2-minutes' interval, and using these numbers as ordinates corresponding to the mid times. The theoretically more perfect method is to pass the detector currents through a sensitive galvanometer possessing a heavy moving system.

The author then turns to a mathematical discussion on the ionisation of the higher and rarer regions of the atmosphere. H. H. H.

## DISCHARGE AND OSCILLATIONS.

**110.** *Phosphorus-content of Phosphorus Fog Particles.* **K. Przibram.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 247–254, Feb., 1912.)—The charge of the particles in a phosphorus fog has been found to be $6 \times 10^{-10}$ e.s. unit [see Abstract No. 1471 (1910)]. If this is correct, then to account for it we must assume that the density is 1·4 and that the phosphorus contained is in the form of phosphoric acid [see Abstract No. 738 (1912)]. It is now found that, under the given conditions, in a phosphorus fog, with each electrostatic unit there is on the average $1{\cdot}43 \times 10^{-6}$ gm. phosphorus. In each cm.$^3$ of phosphorus air there are in the mean over $1{\cdot}54 \times 10^{-2}$ e.s. units of one sign. It appears that both signs are about equally represented. If the average charge is $9 \times 10^{-10}$ e.s. unit there are $1{\cdot}7 \times 10^7$ particles of one sign in each cm.$^3$. The phosphorus-content of a particle is in the mean $1{\cdot}3 \times 10^{-15}$ gm.

A. E. G.

**111.** *Spontaneous E.M.F. in Cells of Alkali Metals.* **J. W. Woodrow.** (Phys. Rev. 35. pp. 208–209, Sept., 1912. Electrician, 70. pp. 282–283, Nov. 15, 1912. Abstract.)—An investigation of the negative charge spontaneously developed by the alkali metal in photo-electric cells, leads to the conclusion that positively-charged particles are given off by the metals in a high vacuum, the emission being sufficient at high temperatures to counterbalance the ordinary photo-electric effect in the light. Apparently only a very small proportion of the atoms in the surface layer of the alkali metal are active, the number increasing with the temperature. Experiments have been made with cæsium, potassium, and an alloy of Na and K in quantities proportional to their atomic weights, a max. potential of 2·2 volts being obtained at about 75° C., and a minimum of 0·73 volt at 25° C. At low temperatures, the current *i* rises with the temperature up to 0° C., falling again as the temperature rises to 80°. Above 80° it increases with the temperature according to the equation $i = aT^{1/2}e^{-b/T}$, where *a* and *b* are constants, and T the absolute temperature. If an electrode of Al is used, the surface of the Na-K alloy becomes coated with a white film, even with the best possible vacuum, unless the cell is exposed to light while short-circuited, but whether this is due to gases contained in the Al electrode or to some action between the alkali vapour and this electrode has not been determined. No film occurs with a Pt electrode. W. H. St.

112. *Positive Rays.* **W. Wien.** (Ann. d. Physik, 39. 3. pp. 519–544, Oct. 15, 1912.)—In a former paper [see Abstract No. 961 (1910)] results were described which show that in oxygen canal rays there is a decrease in the ratio of negative to positive ions when the observation tube is cooled, and it was thought probable that this behaviour of the negative atom is to be attributed to the presence of Hg vapour. It was, however, not proved that other vapours which might have a similar effect were not simultaneously removed. One object of the present experiments is to prove, if possible, a direct action of the Hg vapour. By a special arrangement of the cooling tubes it is shown that on account of the presence of Hg vapour the oxygen canal rays do contain an excess of negative ions. The other problems considered are: the passage of oxygen canal rays through $CO_2$, and determination of the mean free path of the canal rays. The latter is dealt with in sections, viz. Theory of the recharging phenomena in canal rays. Experimental arrangements for measuring the free paths. Observations. Control of the measurements of $L_1$ by the direct determination of $L_2$ ($L_1$ being the mean free path of the charged atom, $L_2$ that of the uncharged). Comparison of the number of collisions with the quantity of light of line $H_\beta$ emitted by canal rays. A. E. G.

113. *Generation of Light in the Glow Discharge and Canal Rays.* **L. Vegard.** (Ann. d. Physik, 39. 1. pp. 111–169, Sept. 5, 1912.)—By Stark's discovery that the canal-ray particles themselves emit light, a new means of studying light-excitation is obtained. The Doppler-effect enables the displaced light to be observed, and by variations in the conditions of discharge and collision the conditions of excitation can be altered in a known manner. The views of various observers are stated, and since there appear to be no satisfactory results as to the laws and variations respecting the series spectrum of hydrogen, the intensity distribution of that spectrum under different conditions of excitation is made the principal object of the present experiments. The question is dealt with as follows:—Comparison of the intensity distribution of the hydrogen series spectrum for negative glow and canal rays with the same discharge conditions. Proof and measurement of a possible displacement in the distribution of the total intensity by alteration of the discharge potential. Separation of the potential and pressure effects in total observed displacement. Explanation of the pressure and potential effects by analysis of the "moving" and "rest" intensity. Dependence of the intensity of the light in the "rest" and "moving" intensity on the velocity of the rays and the pressure of the gas into which the rays enter.

It is found that the intensity distribution of "rest" intensity is invariable within the limits of the experiments. The intensity distribution of the "moving" intensity shows no marked alteration with the potential so long as the pressure in the observation space remains constant. It is also usually different from that of the "rest." The ratio of "moving" to "rest" intensity of a line changes greatly with the potential, the ratio always decreasing with increasing potential. It is also altered by a change of pressure in the observation space. The "rest" intensity becomes relatively smaller as the pressure is lowered. The intensity distribution of the "moving" spectrum shows a very marked pressure effect, so that the difference between the distribution in the "moving" and "rest" spectrum is decreased by a lowering of the pressure. The intensity distribution of the "rest" spectrum is identical with that of the negative glow, a fact which makes it all the more probable that the excitation process is the same in both cases. In an appendix the influence of the charged condition on the properties of the emitted light is considered. A. E. G.

**114.** *Oscillations in Poulsen Arc Circuit.* **K. Ort.** (Jahrbuch d. Drahtlosen Telegraphie, 6. pp. 119–132, Sept., 1912.)—The author uses the Braun tube for the investigation of oscillations generated by the Poulsen arc. He obtains Lissajous figures on the screen of the tube by deflecting the kathode beam, in a direction perpendicular to that due to the oscillation under investigation, by means of a pure sine oscillation which is obtained from a subsidiary circuit of large self-induction and small capacity in tune with and very loosely coupled with the arc circuit. The sine oscillation deflects the beam electrostatically. Curves of the oscillations deduced from the figures are given. They agree with the observations of others and with theory. T. P. B.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**115.** *Electric Conductivity of Bismuth-Thallium Alloys.* **A. E. Whitford.** (Phys. Rev. 35. pp. 144–147, Aug., 1912.)—The investigation described was undertaken to study further the extent to which compounds, as determined from the melting-point curve, influence the trend of other physical properties of alloys. The specimens were cast in glass tubing in an atmosphere of hydrogen, and care was taken to ensure a homogeneous mixture in the preparation of the alloy. The results are given in a table showing the electrical conductivity of each specimen and its method of preparation. From the graphical summary it is seen (as was to be expected) that a discontinuity occurs on the conductivity curve at 63 per cent. Bi, corresponding to $Bi_5Tl_3$, but an ordinary cusp is not formed at this point. At the other Bi-Tl compound (10·9 % Bi) no discontinuity was detected. The characteristics of this curve agree with those of the magnetic susceptibility curve of the Bi-Tl series. J. J. S.

**116.** *Variation of Electrical Resistance of Oxides with Temperature.* **A. A. Somerville.** (Metallurgical and Chem. Engin. 10. pp. 422–423, July, 1912.)—Resistance as a function of the temperature of various oxides was measured. At ordinary temperatures the oxides were as a rule non-conductors. As the temperature rises the resistance decreases, and at 1000° C. most of them may be classed as conductors. The oxide in the form of a powder was placed in a porcelain or quartz tube about 1 cm. in diam. and 10 cm. in length. Nickel rods were made to fit into the ends of the tube against the ends of the column of oxide which was about 5 cm. long. Pressure was put on the ends of the nickel rods to produce constant contact on the oxide. The oxide was heated in its containing tube in a tubular resistance furnace, and temperature was measured by a Pt-resistance thermometer. There is a marked similarity in the way in which the resistance of the various oxides changes with temperature. The materials used, with the temperature at which each has a resistance of 10,000,000 ohms are as follows:—ZnO, 398° C.; $Fe_2O_3$, 252°; CuO, 290° (first heating); CuO, 395° (after once melted); $Cu_2O$, 187° (first heating). $Cu_2O$, after first heating, measures 90,000 ohms at 0° C.; MgO, 545°; $MnO_2$, 120°. The resistance in ohms of these substances at 1100° C. is as follows:—MgO, 1200; $Cu_2O$—changed to Cu + CuO at about 800° C.; $Cu_2O$, 18—(after first heating); CuO, 85 at 1084° (melting-point); CuO, 1600 (after once melted); $MnO_2$, 70; ZnO, 72; $Fe_2O_3$, 80; $Al_2O_3$, ? (infinite). J. J. S.

117. *Effect of Temperature and Transverse Magnetisation on the Resistance of Graphite.* **D. E. Roberts.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 148–155, Sept. 3, 1912.)—About twenty specimens of Ceylon graphite were investigated, which all gave variations of resistance of a high order at ordinary temperature (18°). The increase of resistance in a field of 20 kilogauss varied between 300 and 500 % of the resistance in zero field, no doubt owing to impurities and the difficulty of obtaining specimens of graphite of definite crystalline structure. The isothermal curves showing effect of transverse magnetisation can be represented by the formula: $R'/R_0 = R/R_0 + AH^n$, where $R_0$ is resistance at 0° for $H = 0$, $R$ = resistance at $\theta°$ for $H = 0$, $R'$ = resistance at $\theta°$ in transverse field H, and A and $n$ are constants. From the above equation taking logarithms—

$$\log (R' - R)/R_0 = \log A + n \log H,$$

which can be represented by a straight line, the co-ordinates being $\log (R' - R)R_0$ and $\log H$. The value of $n$ is the same for 5 specimens specially examined. Experiments were made at −179°, 0°, +18°, +95°, and +179°, the field varying from 0 to 40 kilogauss. The increase of resistance is much greater at low temperatures. At the temperature of liquid air the increase is 9300 % for a field of 38·8 kilogauss, the increase at 18° being 1250 %. J. J. S.

118. *Polarisation E.M.F. of a Mixture of Clay, Felspar, and Quartz.* **A. A. Somerville.** (Electrical World, 60. pp. 403–405, Aug. 24, 1912.)—Investigations were made of the electrical resistance and temperature coefficient of oxides and rare earths in the form of powders. It was found that the Nernst filament and Pt give the largest thermal e.m.f. of any materials known. A mixture of clay, felspar, and quartz acts as a sort of storage battery or condenser, and gives out a current with a definite e.m.f. for some hours after it has been charged. The e.m.f. depends upon temperature, time of charging, and the voltage and electrodes used. The mixtures used varied in composition; the clay was composed of equal parts of English ball clay and English china clay, and these were mixed with powdered felspar and quartz. At ordinary temperatures the mixtures were almost complete insulators, but between 400° and 700° C. the resistance decreases rapidly, and then at 1000° the rate of change is much less. The specimens were suspended in a horizontal tubular specially-wound furnace. The temperature was measured

by a resistance thermometer. At about 1000° C. it was found that in that arm of the Wheatstone bridge in which the specimen was placed (in measuring the resistance) there was a polarisation e.m.f. This was examined and was found to be a function not only of the electrolyte but also of the electrodes as well, and the rate of discharge depends on the size of the electrodes. The voltage obtained is a function of the charging e.m.f. The counter-e.m.f. is also dependent upon the temperature, and decreases as the latter increases. J. J. S.

**119.** *Resistance between Metal and Crystal at Flat Surfaces of Separation.* **F. Streintz.** (Phys. Zeitschr. 13. pp. 673–677, July 15, 1912.)—Silver litharge was examined in small cylinders of 4·2 mm. height with diam. of flat surface 9·8 mm. The dependence of the apparent resistance upon the current strength and the pressure between smooth polished silver plates was extraordinarily great. Also with long-continued application this resistance was in a high degree dependent on the respectively applied current strengths. If the transition resistance, as the author conjectured, were due to layers of gas which were held on the surfaces of the crystals, it would appear not to be impossible to free the crystals from this. In liquid air the conductivity rapidly rises so that over 200° its resistance is only a small fraction of an ohm. Silver glance possesses also the peculiarity that when placed close to a metal it gives off sulphur and causes the formation of a new sulphide. Between gold leaves its position is indicated after a few days by the tarnishing of the metal even at ordinary temperatures. At higher temperatures a brown-red stain is produced due to gold sulphide. An atmosphere is formed close to the surface of the crystals, and the transition resistance seems to be caused by the layer of gas. This was confirmed by further experiments. Silver glance is not singular in its behaviour: other similar crystals gave similar results. In one case the effect of heating the surface was to reduce the resistance to one-tenth of its former value by abolishing the layer of gas. For this purpose electric ovens and sometimes a spirit lamp were used. J. J. S.

**120.** *Relations between the Electric and Magnetic Fields of a System of Parallel Conductors of Infinite Length.* **O. Colard.** (Assoc. Ing. Él. Liége, Bull. 12. pp. 335–339, July, 1912.)—The author assumes that the resistivity of the conductors is zero. The magnetic force at a point at a distance $r$ from an infinite straight filament of current of magnitude $i$ is $2i/r$. The direction of the force is at right angles to the radius $r$ in a plane at right angles to the filament. If the filament instead of carrying the current $i$ is charged with $q$ units of electricity per unit length, the electric force is $2q/r$, the direction of the force being along $r$. The author proves that if L be the self-inductance, C the capacity, etc., of the various wires $(\Sigma \mathrm{L}i^2)/(\Sigma q^2/\mathrm{C}) = \lambda/\mu$, where $\lambda$ is the dielectric coefficient, and $\mu$ the permeability of the medium. For two parallel wires $\mathrm{CL} = \lambda\mu = 1/v^2$, where $v$ is the velocity of light. A. R.

**121.** *Measurement of Mutual Induction.* **F. Kock.** (Jahrbuch d. Drahtlosen Telegraphie, 6. pp. 118–119, Sept., 1912.)—The author determines the coefficient of mutual induction between two coils as follows:—A condenser circuit, containing one coil and a thermo-element, is excited by undamped oscillations of low or high frequency. The second coil is closed through a thermo-element, and the effective current strengths, $\mathrm{I}_1\mathrm{I}_2$, in the two circuits are obtained. Then $\mathrm{I}_1\mathrm{I}_2 = \sqrt{(r_2^2 + p^2\mathrm{L}_2^2)}/p\mathrm{M}$, where $p = 2\pi n$, $r_2$ and $\mathrm{L}_2$ are respectively the alternating-current resistance and the self-induction of the second coil; M is the coefficient of mutual induction. Results by this method are shown to agree well with those obtained by other methods.

T. P. B.

122. *Dielectric Hysteresis.* **W. M. Thornton.** (Phys. Soc., Proc. 24. pp. 301–315; Discussion, pp. 315–316, Aug., 1912.)—The polarisation in a solid insulator in a steady and uniform field of electric force differs from other polarisation, mechanical or magnetic, in the manner in which the final value is reached. After the initial displacement at the velocity of electromagnetic waves in a medium which occurs on starting the field there is a slow increase of polarisation maintained at a uniform rate for several hours, and the final value at which equilibrium is reached is independent of the intensity of the external field [see Abstract No. 612 (1910)]. The polarisation decays, on stopping the latter, at the same rate as that at which it was established, and in the end entirely disappears. The effect (common to all dielectrics) is an example of "elastic afterworking" unique in range and duration. There is a well-marked period of transition between the first polarisation and the complete establishment of the second stage, and in this any electric hysteresis loss must arise, for in the first stage the displacement is elastic, and in the second is unaffected by the external field. In the paper the author endeavours by the examination of wave-forms of alternating current in condensers built up of flat sheets of dielectric, to find the range and magnitude of polarisation under simple harmonic electric stress, at a frequency low enough to retain the features of hysteresis observed in steady fields, and high enough to be examined by the oscillograph in the usual way. The effect is observed in practice by the accumulation of charge on the conductors of direct-current cables left insulated after use, giving rise to voltages sometimes greatly in excess of the working pressure. It is observed in high-voltage alternating-current systems by heating of the insulation of cables through the conductor of which the only current passing is that required to supply the dielectric polarisation. The condensers used in the experiments described were made up with flat sheets of dielectric overlapping intermediate sheets of tin-foil. The substances used were glass, ebonite, india-rubber, gutta-percha, paraffined paper, Empire cloth, Empire paper, press-spahn, and a paper impregnated with a resin-oil compound used in the manufacture of high-tension paper-insulated cables. The frequency was constant throughout at 86·5 complete periods per second. From the dielectric hysteresis loops the nature of the change of polarisation which gives rise to the absorption of energy was investigated. Current and voltage wave-forms were oscillographically recorded. Certain substances, like glass or gutta-percha, were found to show a marked triple-frequency harmonic in the current wave out of phase with the fundamental. Most of these have a low power factor; others, like press-spahn, show little distortion, but have a high power factor. The loops for the former have straight parallel sides and a true hysteresis retardation as the voltage begins to fall; the latter have lens-shaped loops corresponding to a purely viscous retardation. Every variety of transition is observed between these extreme types. The cause of the former is probably inter-attraction between the induced molecular charges reaching a maximum at the highest voltage; that of the latter is a resistance to their movement through the substance during the establishment of the usual polarisation, the retardation being at a maximum when the rate of change of the voltage is greatest—*i.e.* in passing through zero. The dielectric constants of substances

with lenticular loops are more affected by change of frequency than the straight-sided type, that of press-spahn changing from 4·8 at 78 ∿, to 6·8 at 15 ∿ per sec. Ebonite and paraffined paper change by less than 1 per cent. during the same range. For the same substances change of voltage gradient, short of breakdown voltage, has little or no influence on dielectric constant at this frequency. Power factor appears to increase with frequency within the range determined. J. J. S.

123. *Recent Improvements in the String Electrometer.* **C. W. Lutz.** (Phys. Zeitschr. 13. pp. 954–962, Oct. 15, 1912.)—Illustrated.

## ALTERNATING CURRENTS AND MAGNETISM.

124. *Action of an Intermittent Contact in an Alternating-current Circuit containing Capacity.* **A. Lampa.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 899–940, May, 1912.)—It was found that when a circuit containing a glow-lamp and a condenser in series is connected to a supply of alternating current through a contact consisting of a brass brush pressing lightly on a rotating copper disc, the effective current is greater than when connection is through a fixed contact. The effect is due to rapid make and break at the contact, arising from irregularities in the surface of the disc. The mathematical theory of the phenomenon is investigated at some length. F. T. C.

125. *Subsequent Magnetism of Iron.* **A. Bernini.** (N. Cimento, 4. Ser. 6. pp. 133–143, Aug., 1912.)—The paper is the third of a series and deals with the law according to which the specimen attains its final steady condition for decreasing magnetisation, the former papers [Abstracts Nos. 590, 1114 (1912)] having dealt with the similar phenomenon for increasing field. The same equation containing two constants is found to apply as in the former case; the constants are, however, not in general the same, but become so in the case in which there is residual magnetism. (*Addendum*, Ibid. p. 256, Sept.)
S. G. S.

126. *Measurement of Magnetic Field Intensity.* **W. Rogowski** and **W. Steinhaus.** (Archiv. f. Elektrotechnik, 1. pp. 141–150, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—The magnetic properties of a material are usually given by a curve showing B as a function of H. While the former quantity is easily measured by ballistic and other methods, the latter is difficult to measure. To overcome this difficulty the authors propose to use a coil which they term a magnetic intensity meter. The flux in a uniformly-wound coil which has everywhere the same cross-section is proportional to the magnetic force between the beginning and end of the coil, and the direction of this force is along the axis of the coil. Such a coil can be used as a magnetic intensity measurer. The method of experimenting lies in the measurement of the closed line integral of magnetic force. This according to theory should be constant for all paths which involve the same circulation and should vanish if there is no flow in the enclosed circuit. If iron is brought into the field it can distort the magnetic field, but the line integral of magnetic force should be unchanged. In the paper the authors give an account of the practical application of this principle to the measurement of H in yoke and other such magnetic tests. A. D. R.

127. *Effect of Quenching on the Magnetic Properties of Metals and Compounds.* **K. Honda.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 19. pp. 2–285,

Sept., 1912.)—The author discusses the question as to whether quenching can be considered effective in fixing at room temperature the properties of a material corresponding to high temperatures. From tests on various metallic elements, alloys and compounds, he considers that in general quenching is ineffective. The manganese steels, however, are an exception to the general rule. A. D. R.

128. *Hysteresis of Iron under Electrical Oscillations.* **H. Fassbender** and **E. Hupka.** (Jahrbuch d. Drahtlosen Telegraphie, 6. pp. 133–146, Sept., 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—A more complete account of the work dealt with in Abstract No. 935 (1912).

## RADIOLOGY AND ELECTROPHYSIOLOGY.

129. *Intensity Distribution of Röntgen Rays from a Platinum Antikathode.* **W. Friedrich.** (Ann. d. Physik, 39. 2. pp. 377–430, Sept. 24, 1912. Extract of Dissertation, Munich.)—The first researches dealing with the intensity distribution of Röntgen rays were undertaken by Röntgen in 1897. Using a photometer method he compared the intensity of the light on a barium platinocyanide screen placed in different emission directions at equal distances from the antikathode. He also exposed photographic films bent in a semicircle round the Pt antikathode. From his results he came to the conclusion that the Röntgen rays had an approximately uniform intensity distribution. He noticed a slight decrease with emission angle 80°, while the main alteration in intensity appeared to take place between 89° and 90°. More recently B. Walter, who repeated Röntgen's photographic experiments, found that when allowance is made for the want of uniformity in the walls of the tube, the intensity distribution is approximately uniform. He attributes the rapid decrease in intensity for angles greater than 80° as observed by Röntgen, to absorption of Röntgen rays by the antikathode. In the present paper the dependence of the intensity on the azimuth is the object of research, special consideration being given to variations due to tube-wall; both photographic and electrical methods being employed. In general very similar results are obtained by the two methods. As a rule, the ionisation method is employed for quantitative measurements. It is found that the intensity of Röntgen rays emitted by a Pt antikathode (after passing through a uniform thickness of 2 mm. tube-wall) are dependent upon the azimuth, *i.e.* on the angle which the axis of the pencil of kathode rays makes with the axis of the pencil of Röntgen rays generated by them. The max. intensity does not lie in a direction at right angles to that of the propagation of the kathode rays, but is displaced to the side of azimuth less than 90°. The greater the hardness of the rays the larger is this displacement. The measurement of the intensity distribution by the electrical method gives a mean difference between rays of azimuth 150° and those of azimuth 80°, of 20%. The hardness of the Röntgen rays is also a function of the azimuth. It increases with diminishing azimuth. By photographic means it is shown that a minimum of Röntgen-ray intensity generated by a Pt antikathode and having passed through 0·01 mm. of Al occurs at azimuth 0°. A. E. G.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

130. *Adsorption of Gases by Carbon and other Porous Substances.* **W. Hempel** and **G. Vater.** (Zeitschr. Elektrochem. 18. pp. 724–727, Aug. 15, 1912. **G. Vater**, Dissertation, Techn. Hochschule, Dresden.)—Experiments were made with different kinds of charcoal, kieselguhr, bog ore, spongy platinum, bone ash, peaty earth, etc. It results that blood charcoal absorbs all gases (H, O, N, A, NO, $H_2S$, CO, $CO_2$, $CH_4$, $C_2H_6$, Cl, $NH_3$), etc., much better, at + 20°, — 78°, — 185° C., than cocoa-nut charcoal; gas-analytical separations of diatomic gases are not possible by these means, however. Much depends upon the temperature at which carbonisation takes place; the best temperature for both charcoal and the authors' special blood charcoal is 600° C. H. B.

131. *Connection between the Chemical Characteristics of Radio-elements and the Series of Radio-active Transformations.* **G. v. Hevesy.** (Phys. Zeitschr. 13. pp. 672–673, July 15, 1912.)—RaC separates itself electrolytically more easily than RaB, RaF more easily than RaE, and so on. These facts lead to the generalisation that radio-active transformation always takes place in such a direction that the existing product is electrochemically more stable than the disintegrating one. This is known as the Lucas-Lerch law. To investigate the correctness or otherwise of this law the author examined the behaviour of RaA whose period is of the same order of magnitude as those of RaB and RaC. The active deposit was obtained on a small piece of Na metal, with which also the active deposit existing on the surface of the latter very quickly went into solution. The alkaline solution was neutralised with $H_2SO_4$, copper sulphate added and a copper plate dipped for 45 secs. in the solution. A curve showing the result is given. The active deposit was collected during 12·5 mins. and the copper plate dipped in the solution 4·8 mins. after the interruption of the exposure. The simple relation which is observed between the chemical and other peculiarities of the radio-elements is this, that the radium transformation products yielding $\alpha$-rays: RaF, RaC, and RaA—are more easily deposited than the $\beta$-products. The examination of the electrochemical behaviour of RaA—which shows itself more stable than RaB but less stable than RaC—affords a further decisive example that there exists no thorough connection between the electrochemical behaviour of the radio-elements and the order of succession of radio-active transformations. J. J. S.

132. *Influence of Vortex Motion on the Structure of Liquid Crystals.* **Lehmann.** (Ann. d. Physik, 39. 1. pp. 80–110, Sept. 5, 1912.)—The view is adopted that apart from the surface, where the molecular structure is rendered anisotropic by friction, crystalline fluids of small viscosity show the same hydrodynamic stream-lines as ordinary amorphous fluids. The molecular structure is not affected by flow if the orientation of the molecules is maintained by contact with solid substances or strong magnetic fields. T. M. L.

133. *Optical Investigation of Crystallised Nitrogen, Argon, and Methane.* **W. Wahl.** (Roy. Soc., Proc. Ser. A. 87. pp. 371–380, Oct. 2, 1912.)—The substances were crystallised and examined in a quartz glass vessel, holding a

very thin layer (0·05 mm.) of substance between polished glass plates. It was found that nitrogen, argon, and methane crystallise in the cubic system. Ethyl ether is rhombic; ethyl alcohol, acetone, methyl alcohol and carbon disulphide are monoclinic or triclinic. Methyl alcohol occurs in two polymorphic forms, changing reversibly into each other. T. M. L.

134. *Crystallisation of Cold-worked Metals effected by Annealing.* **F. Robin.** (Comptes Rendus, 155. pp. 585–587, Sept. 23, 1912.)—The author has annealed thin (0·5 mm. thick) cold-rolled plates of various metals at various temperatures and has observed the crystal growths. The results indicate that the growth does not increase in proportion to the temperature if the time of heating is kept constant, and it appears that for pure metals and solutions the largest grains are not always obtained at the highest temperature, nor the smallest at the lowest temperatures of heating. Generally speaking, impurities reduce the scale of the grain-size without sensibly affecting the temperature at which annealing begins. The degree of reduction varies considerably with the nature of the impurity. Aluminium and magnesium have the greatest effect on tin, lead and zinc. F. C. A. H. L.

135. *Relations between the Macrostructure and Crystallisation of Steel.* **N. T. Belaiew.** (Soc. Métallurg. russe, Journ. 1. pp. 21–38, 1910. Rev. de Métallurgie, 9. pp. 647–680, Sept., 1912. Paper read before the Congres des Mines, de la Métallurgie, et des Constructions mécaniques, Ekaterinoslaw, Sept. 1, 1910.)—From a long series of observations of the macrostructure of both ordinary and alloy steels and an examination of the developed crystals often found in the pipes and cavities in ingots, the author concludes that cast steel is composed, both externally and internally, of crystals similar to those developed in pipes and cavities. The size, shape, and distribution of the crystals depend upon the mass, section, and composition of the ingot and also upon the process of cooling, etc. These crystals are produced during the period of solidification and their formation is revealed by the macrostructure which is a result of irregularities in composition and is typical for all classes of steel. Generally speaking, the macrostructure cannot be modified at the temperatures attained in the course of ordinary thermal or mechanical operations, so that it really represents the stable structure of the steel. Cold mechanical work only produces deformation of the crystals, while hot treatment only produces local changes in each of the particles constituting the macrostructure. Consequently the difference between the three types of steel is: (1) cast steel is made up of crystals of various shapes and sizes arranged haphazard, (2) mechanically worked steel consists of the same crystals more or less displaced according to the nature and degree of working, and (3) thermally worked steel is always made up of the same primitive crystals either in their natural or deformed state, but the constituent parts of the crystals have been altered as a result of equilibrium changes determined by the temperature and other conditions of the thermal treatment. F. C. A. H. L.

136. *Exothermic Steel.* **W. O. Amsler.** (Metallurgical and Chem. Engin. 10. pp. 559–562, Sept., 1912.)—This steel is produced by an exothermic reaction according to the equation $Fe_2O_3 + 2KAl_2Si_3O_8 + 2Al_2O(OH)_4 + CaO = 2Fe + 4Al_2O_3, 6SiO_2, 2KOH, CaO + 3H_2O$, which takes place when iron oxide, felspar, bauxite and lime are heated together. Excess

iron oxide and the corresponding amount of charcoal are added to keep down the temperature, which may rise very high. The reaction is carried out in a stack furnace heated by an oil burner and the products of combustion are drawn off at the top by means of an exhauster and passed through a scrubber. Carbon is added in an open-hearth furnace and the resulting metal is unusually quiet, giving an ingot free from pipe and segregation. Tests on 1·16 per cent. carbon steel made in this way showed that a 1-in. octagon bar would bend double without a sign of fracture. It is claimed that the steel gives from two to five times the service of the best nickel steel forgings. F. C. A. H. L.

**137.** *Cryoscopy in Sodium Sulphate Decahydrate as Solvent.* **A. Boutaric** and **C. Leenhardt.** (Comptes Rendus, 155. pp. 825–826, Oct. 28, 1912.)—The "molecular depression" produced by urea in sodium sulphate was found to be 82·05. The value calculated from the latent heat by van't Hoff's formula was found to be 82·08. T. M. L.

**138.** *Investigation of Chemical Reactions taking place at Kathode and Anode during Electrolysis of Simple Salt Solutions.* **J. H. Paterson.** (Univ. of Durham Phil. Soc., Proc. 4. pp. 187–220, 1911–1912.)—The author has devised a special microscopic cell by means of which the kathode reactions of the metals Co, Ni, Fe, Zn, Cd, Mn, Pb, and Sn have been investigated. A number of experiments were also carried out on a larger scale. The experiments with the microscope cell have shown that it is possible to obtain from a number of these metals (Co, Ni, Fe, Zn, Cd, Mn, and doubtfully Pb) either the pure metal or the hydroxide deposited on the kathode. Observations on the conditions of concentration and current density necessary to produce these substances show that as we proceed along the list of metals in the order written, the dilution necessary to produce the hydrate increases and the limit of current strength decreases. The hydroxide of the metal is not produced as a secondary reaction of the metal deposited on the kathode, but is formed as a precipitate from the electrolyte in the kathode area. The formation of the metal or hydroxide according to the varying conditions can readily be explained by the application of Nernst's theory of potential and over-voltage. In view of the fact that the hydroxides of nearly all the metals above hydrogen in the potential series can be found at the kathode, it is probable that the spongy metallic deposits produced by the use of too high current densities contain the hydroxides of the metals as impurities, if they contain any impurities at all. With respect to anode reactions, the chemical conditions under which precipitates are obtained vary considerably. With Ni and Co, for example, anode precipitates are not produced under any conditions when simple salts are used, but are produced readily enough when sufficient ammonium sulphate or nitrate is added to produce the double salt, and disappear again on adding excess of the salt or of ammonia. With Ag and Pb, on the other hand, precipitates are produced on the electrolysis of the simple nitrates, and with manganese on the electrolysis of any of its salts. All the metals which produce anode deposits are metals having valencies of two or more orders of magnitude. T. S. P.

**139.** *Rapid Electro-analysis under diminished Pressure.* **F. Fischer** and **E. Stecher.** (Zeitschr. Elektrochem. 18. pp. 809–816, Sept. 15, 1912.)—The method already described [see Abstract No. 118 (1912)] has been further tested in the estimation of single metals, as also in separations. Zinc, like copper, can only be rapidly estimated under diminished pressure when the temperature is high. The method is suitable for the estimation of Ni, but not particularly so for the estimation of lead as dioxide. Good results were obtained in the estimation of Cu in brass, the separation of Cu and Ni, and the separation of Ag and Cu. In the latter case neutral or acidified solutions of the sulphates were used, and Brunck's method of using an Edison accumulator was adopted. The advantage of the use of diminished pressure is shown by the fact that 0·1 gm. of silver can be deposited in 15 minutes, whereas Brunck's method requires about an hour to do this, and the complete determination of Ag and Cu occupies only three-quarters of an hour. A special arrangement for washing a deposit without interrupting the current is described. T. S. P.

140. *Influence of Colloids on the Electrolytic Deposition of Lead.* **H. Freundlich** and **J. Fischer.** (Zeitschr. Elektrochem. 18. pp. 885–891, Oct. 15, 1912.)—From various theoretical considerations the authors come to the conclusion that the formation of an electrolytic deposit depends ultimately (1) on the number of crystal nuclei formed from the discharged metal atoms; (2) on the velocity of crystallisation of the metal on the surface of the electrode. If (1) is small in comparison with (2) the crystal nuclei will grow quickly to large crystals, the discharged metal atoms being used up in this way without having the opportunity of forming new nuclei; the deposit will consequently be coarse and crystalline. On the other hand, if (1) is large in comparison with (2), supersaturation occurs with respect to the discharged metal atoms, so that fresh nuclei will continually be formed and consequently a larger number of small crystals, giving a compact deposit. Marc has shown that colloids have a very considerable effect in diminishing the velocity of crystallisation, which is in favour of the above theory. For a number of colloids (gelatine, agar-agar, casein, traganth, and dextrine) the authors have determined the minimum quantity necessary to give a good deposit of lead, under given conditions of current density and time, from solutions of the perchlorate and silicofluoride, and also the protective action of such colloidal solutions on a gold hydrosol. The two things are not exactly parallel, but the results of the experiments allow of the interpretation that the colloids are absorbed by the metal, thus reducing the velocity of crystallisation and favouring a compact deposit. Further evidence in support of the assumption that the velocity of crystallisation is the deciding factor is found in the fact that gelatine has a similar influence on the nature of the deposit of lead obtained by immersing zinc in solutions of the lead perchlorate and silicofluoride to what it has on the electrolytic deposit. T. S. P.

141. *Dependence of Crystal Form on Temperature.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 557–565, 1912.)—Deals with about twenty inorganic compounds. E. H. B.